This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Y 4Ag8/1:100-40

FOREST ECOSYSTEMS AND ATMOSPHERIC POLLUTION RESEARCH ACT OF 1987

R56189N

CIS RECORD ONLY:

HEARING

BEFORE THE

SUBCOMMITTEE ON FORESTS, FAMILY FARMS,
AND ENERGY

OF THE

COMMITTEE ON AGRICULTURE
HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON

H.R. 2399

JUNE 9, 1987

Serial No. 100–40

STANFORD UNIVERSITY
MAY 1988
LIBRARY OF GOVT DOCUMENTS

Printed for the use of the Committee on Agriculture

U.S. GOVERNMENT PRINTING OFFICE
78-956 WASHINGTON : 1987

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

COMMITTEE ON AGRICULTURE

E (KIKA) de la GARZA, Texas, *Chairman*

WALTER B. JONES, North Carolina
ED JONES, Tennessee
GEORGE E. BROWN, Jr., California
CHARLES ROSE, North Carolina
GLENN ENGLISH, Oklahoma
LEON E. PANETTA, California
JERRY HUCKABY, Louisiana
DAN GLICKMAN, Kansas
TONY COELHO, California
CHARLES W. STENHOLM, Texas
HAROLD L. VOLKMER, Missouri
CHARLES HATCHER, Georgia
ROBIN TALLON, South Carolina
HARLEY O. STAGGERS, Jr., West Virginia
LANE EVANS, Illinois
ROBERT LINDSAY THOMAS, Georgia
JIM OLIN, Virginia
TIMOTHY J. PENNY, Minnesota
RICHARD H. STALLINGS, Idaho
DAVID R. NAGLE, Iowa
JIM JONTZ, Indiana
TIM JOHNSON, South Dakota
CLAUDE HARRIS, Alabama
BEN NIGHTHORSE CAMPBELL, Colorado
MIKE ESPY, Mississippi

EDWARD R. MADIGAN, Illinois,
Ranking Minority Member
JAMES M. JEFFORDS, Vermont
E. THOMAS COLEMAN, Missouri
RON MARLENEE, Montana
LARRY J. HOPKINS, Kentucky
ARLAN STANGELAND, Minnesota
PAT ROBERTS, Kansas
BILL EMERSON, Missouri
SID MORRISON, Washington
STEVE GUNDERSON, Wisconsin
TOM LEWIS, Florida
ROBERT F. (BOB) SMITH, Oregon
LARRY COMBEST, Texas
BILL SCHUETTE, Michigan
FRED GRANDY, Iowa
WALLY HERGER, California
CLYDE C. HOLLOWAY, Louisiana

Professional Staff

A. Mario Castillo, *Chief of Staff*
Phillip L. Fraas, *Counsel*
Charles Hilty, *Minority Staff Director*
James A. Davis, *Press Secretary*

Subcommittee on Forests, Family Farms, and Energy

HAROLD L. VOLKMER, Missouri, *Chairman*

JIM OLIN, Virginia
BEN NIGHTHORSE CAMPBELL, Colorado
LEON E. PANETTA, California
CHARLES HATCHER, Georgia
RICHARD H. STALLINGS, Idaho
TIM JOHNSON, South Dakota
CLAUDE HARRIS, Alabama
JIM JONTZ, Indiana

SID MORRISON, Washington
RON MARLENEE, Montana
ROBERT F. (BOB) SMITH, Oregon
BILL SCHUETTE, Michigan
WALLY HERGER, California
CLYDE C. HOLLOWAY, Louisiana

CONTENTS

Page

H.R. 2399, a bill to provide for study and research on the decline in U.S. forest productivity and to determine the effects of atmospheric pollutants on forest environments, and for other purposes 3
  Report from U.S. Department of Agriculture 9
de la Garza, Hon. E (Kika), a Representative in Congress from the State of Texas, statement 21
  Prepared statement 23
Harris, Hon. Claude, a Representative in Congress from the State of Alabama, opening statement 12
Morrison, Hon. Sid, a Representative in Congress from the State of Washington, opening statement 11
Smith, Hon. Robert F. (Bob), a Representative in Congress from the State of Oregon, opening statement 11
Volkmer, Hon. Harold L., a Representative in Congress from the State of Missouri, opening statement 1

WITNESSES

Bruck, Robert Ian, associate professor, plant pathology and forestry, North Carolina State University 38
  Prepared statement 74
Ehreth Donald J., Deputy Assistant Administrator, Office of Research and Development, U.S. Environmental Protection Agency 14
  Prepared statement 64
Hinrichsen, Don, editor-in-chief, World Resources Report, World Resources Institute, Washington, DC, and International Institute for Environment and Development, London, England 49
  Prepared statement 86
Leonard, George M., Associate Chief, Forest Service, U.S. Department of Agriculture 12
  Prepared statement 56
Sampson, R. Neil, executive vice president, American Forestry Association 51
  Prepared statement 89
Stout, Benjamin B., national program manager, air quality and forest health, National Council of the Paper Industry for Air and Stream Improvement, Inc 41
  Prepared statement 81

SUBMITTED MATERIAL

Acid Rain, Air Pollution, and Forest Decline, updated May 28, 1987, issue brief, Order Code IB86031, Adela Backiel, Environment and Natural Resources Policy Division, Congressional Research Service, Library of Congress 100

FOREST ECOSYSTEMS AND ATMOSPHERIC POLLUTION RESEARCH ACT OF 1987

TUESDAY, JUNE 9, 1987

House of Representatives,
Subcommittee on Forests, Family Farms, and Energy,
Committee on Agriculture,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:35 p.m., in room 1300, Longworth House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Present: Representatives Olin, Campbell, Panetta, Stallings, Johnson, Harris, Jontz, Morrison, Smith, Schuette, and Holloway.

Also present: Representative E (Kika) de la Garza, chairman of the committee.

Staff present: Phillip L. Fraas, counsel; Glenda L. Temple, clerk; Timothy P. De Coster, James R. Lyons, and Carol Ann Dubard.

OPENING STATEMENT OF HON. HAROLD L. VOLKMER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MISSOURI

Mr. Volkmer. The subcommittee will come to order.

The subcommittee is meeting this afternoon to consider H.R. 2399, the Forest Ecosystems and Atmospheric Pollution Research Act.

The bill is essentially the same as one which was developed in this subcommittee during the 99th Congress. That bill was approved by the full House by a near-unanimous vote, but was not acted upon by the Senate.

The problems addressed by this legislation are of increasing importance as more and more forests in all parts of the country show signs of decline. The causes for these declines are not completely understood and so require further study.

One potential factor in forest decline, which is the subject of a great deal of attention, is acid rain. But there are other atmospheric pollutants, such as ozone, which may play a role, and these must be studied as well.

We will hear today testimony regarding the effects of air pollution on forest productivity and on current research efforts. While we expect to cover some of the same ground as in hearings held on this topic during the 99th Congress, we also hope to learn what new developments have taken place.

I want to welcome our witnesses and thank you all in advance for your participation. The subcommittee also invited testimony from the Director of Research of the National Acid Precipitation

Assessment Program, who declined. NAPAP has an important role in this area and it is unfortunate we do not have someone here to represent that organization. We were informed that one of the Forest Service personnel who are here could speak for NAPAP, so we will do our best to ascertain what we need to know.

[H.R. 2399 and the report from U.S. Department of Agriculture follow:]

I

100TH CONGRESS
1ST SESSION

H. R. 2399

To provide for study and research on the decline in United States forest productivity and to determine the effects of atmospheric pollutants on forest environments, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MAY 13, 1987

Mr. DE LA GARZA (for himself, Mr. MADIGAN, Mr. VOLKMER, Mr. MORRISON of Washington, Mr. FOLEY, Mr. STALLINGS, Mr. JEFFORDS, Mr. OLIN, Mr. HATCHER, Mr. BROWN of California, Mr. BRYANT, Mr. SKELTON, Mr. WILSON, Mr. RICHARDSON, Mr. SCHUETTE, Mr. HERGER, and Mr. HOLLOWAY) introduced the following bill; which was referred to the Committee on Agriculture

---

A BILL

To provide for study and research on the decline in United States forest productivity and to determine the effects of atmospheric pollutants on forest environments, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Forest Ecosystems and Atmospheric Pollution Research Act of 1987".

SEC. 2. FINDINGS.

Congress finds that—

(1) the health and productivity of forests in certain regions of the United States are declining;

(2) existing research indicates that atmospheric pollution, including ozone, acidic deposition, and heavy metals, may contribute to this decline;

(3) there is an urgent need to expand and better coordinate existing Federal, State, and private research, including research by private industry, to determine the cause of changes in the health and productivity of domestic forest ecosystems and to monitor and evaluate the effects of atmospheric pollutants on such ecosystems; and

(4) such research and monitoring should not impede efforts to control atmospheric pollutants.

SEC. 3. ESTABLISHMENT OF RESEARCH PROGRAM.

Section 3 of the Forest and Rangeland Renewable Resources Research Act of 1978 (16 U.S.C. 1642) is amended by adding at the end the following:

"(c)(1) The Secretary, acting through the United States Forest Service, shall establish not later than one hundred and eighty days after the date of the enactment of this subsection a ten-year program (hereinafter in this subsection referred to as the 'Program') to—

"(A) increase the frequency of forest inventories in matters that relate to atmospheric pollution and conduct such surveys as are necessary to monitor long-term trends in the health and productivity of domestic forest ecosystems;

"(B) determine the scope of the decline in the health and productivity of domestic forest ecosystems;

"(C) accelerate and expand existing research efforts (including basic forest ecosystem research) to evaluate the effects of atmospheric pollutants on forest ecosystems and their role in the decline in domestic forest health and productivity;

"(D) study the relationship between atmospheric pollution and other climatological, chemical, physical, and biological factors that may affect the health and productivity of domestic forest ecosystems;

"(E) develop recommendations for solving or mitigating problems related to the effects of atmospheric pollution on the health and productivity of domestic forest ecosystems;

"(F) foster cooperation among Federal, State, and private researchers and encourage the exchange of scientific information on the effects of atmospheric pollutants on forest ecosystems among the United States, Canada, European nations, and other nations; and

"(G) support the long-term funding of research programs and related efforts to determine the causes of declines in the health and productivity of domestic forest ecosystems and the effects of atmospheric pollutants on the health and productivity of domestic forest ecosystems.

"(2) The Secretary shall establish a committee to advise the Secretary in developing the Program, which shall be composed of scientists with training and experience in various disciplines, including atmospheric, ecological, and biological sciences. Such scientists shall be selected from among individuals who are actively performing research for Federal or State agencies or for private industries, institutions, or organizations.

"(3) The Secretary shall coordinate the Program with existing research efforts of Federal and State agencies and private industries, institutions, or organizations.

"(4) The Secretary shall submit to the President and to Congress the following reports:

"(A) Not less than thirty days before establishing the Program, the Secretary shall submit an initial program report—

"(i) discussing existing information about declining health and productivity of forest ecosystems on public and private lands in North America and Europe;

"(ii) outlining the findings and status of all current research and monitoring efforts in North America and Europe on the causes and effects of atmospheric pollution on the health and productivity of forest ecosystems;

"(iii) describing the Program; and

"(iv) estimating the cost of implementing the Program for each fiscal year of its duration.

"(B) Not later than January 15 of each year during which Program is in operation following the year in which the initial program report is submitted, the Secretary shall submit an annual report—

"(i) updating information about declining health and productivity of forest ecosystems on public and private lands in North America and Europe;

"(ii) updating the findings and status of all current research and monitoring efforts in North America and Europe on the causes and effects of atmospheric pollution on the health and productivity of forest ecosystems, including efforts conducted under the Program;

"(iii) recommending additional research and monitoring efforts to be undertaken under the Program to determine the effects of atmospheric pollution on the health and productivity of domestic forest ecosystems; and

"(iv) recommending methods for solving or mitigating problems stemming from the effects of atmospheric pollution on the health and productivity of domestic forest ecosystems.

"(C) Not later than ten years after the date on which the initial program report is submitted, the Secretary shall submit a final report—

"(i) reviewing existing information about declining health and productivity of forest ecosystems on public and private lands in North America and Europe;

"(ii) reviewing the nature and findings of all research and monitoring efforts conducted under the Program and any other relevant research and monitoring efforts related to the effects of atmospheric pollution on forest ecosystem; and

"(iii) making final recomendations for solving or mitigating problems stemming from the effects of atmospheric pollution on the health and productivity of domestic forest ecosystems.".

○

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

July 7 1987

Honorable E (Kika) de la Garza
Chairman, Committee on Agriculture
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

As you requested, here are our views on H.R. 2399, a bill "To provide for study and research on the decline in United States forest productivity and to determine the effects of atmospheric pollutants on forest environments, and for other purposes."

The Department of Agriculture recommends that H.R. 2399 not be enacted.

H.R. 2399, the Forest Ecosystems and Atmospheric Pollution Research Act of 1987, would amend the Forest and Rangeland Renewable Resources Research Act of 1978 to require the Secretary of Agriculture to undertake a comprehensive 10-year program related to atmospheric pollution and forest ecosystems. The Secretary would also be required to establish a multi-disciplinary committee of scientists to advise him in developing the program. The committee would be composed of representatives from Federal and State agencies, private interests, and organizations. The Secretary would also be required to coordinate the program with other existing research efforts and to submit reports to the President and the Congress; including an Initial Program Report not less than 30 days before establishing the program, an Annual Report by January 15 of each year, and a Final Report within 10-years of the Initial Program Report.

New legislation is not necessary for this research to be conducted. The Forest and Rangeland Renewable Resources Research Act provides adequate authority for the research.

Both the Administration and the Congress have supported increased research on acidic precipitation and associated airborne pollutants. The Forest Service is currently conducting an extensive atmospheric deposition research program and plans to increase its effort on forest response to atmospheric stresses. This research includes Federal and State agencies, private interests, and organizations cooperating together to study the effects of atmospheric deposition on selected forest types. Forest effects research is one of the priority initiatives presently being conducted by the National Acid Precipitation Assessment Program.

The Office of Management and Budget advises that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

Peter Myers

PETER C. MYERS
Deputy Secretary

Mr. **Volkmer**. Before I call the first panel, I would like to first recognize the gentleman from Washington for any statement he would like to make.

OPENING STATEMENT OF HON. SID MORRISON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WASHINGTON

Mr. **Morrison**. I thank the chairman for this opportunity for an opening comment.

I have to say, Mr. Chairman, I'm pleased that you have opted to take up this subject. This was one of the most important issues as far as our former subcommittee chairman is concerned because he lived in an area that actually reflected this loss of forest productivity.

I also have to mention that part of the drafting of this legislation is designed to keep it away from some other people, other committees that have made it a point not to allow acid rain or atmospheric pollution issues to get to the floor of the House. So I'm proud of this subcommittee and the full Agriculture Committee for carrying on with what I think is one of our areas of responsibility, an assurance of forest productivity.

I also have to mention the pride that I personally have in the work done by our U.S. Forest Service over the years. We also have an ulterior motive with this legislation, and that is continuing to make sure that this work remains in their hands as an agency.

Again, I commend you, Mr. Chairman. I think the work we're doing on this issue is vitally important. We may be ahead of our times. We're certainly ahead of those who would oppose admitting that there are problems with the pollutants we have in the air and problems for our forests and ecosystems as well.

I thank the chairman.

Mr. **Volkmer**. I thank the gentleman from Washington.

Does anyone else have any statement?

The gentleman from Oregon.

OPENING STATEMENT OF HON. ROBERT F. (BOB) SMITH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OREGON

Mr. **Smith**. Mr. Chairman, thank you. I, too, wish to commend you for this kind of oversight responsibility.

On a personal note, I have just returned from Europe. Czechoslovakia is a country which burns high-sulphur coal, highly toxic. The Czech forests are disintegrating largely due to some kind of toxic substance. They think it's acid rain, but it's obvious that there is some kind of connection.

I was interested a year or so ago in listening to experts from all around the world, including those from Europe, who testified before our committee. They evaluated those countries in the world that have made the most progress against acid rain. It was interesting that France became the one country in the world that has gained more against acid rain and its contaminants than any other country. It's also interesting to note that the reason obviously for that is that they have gone to nuclear power plants almost exclusively.

So we may get to a point, Mr. Chairman, when the question becomes, Do you want to burn fossil fuels or do you want to have some other energy component? While that might be a logical conclusion, it certainly has not been proven. These hearings and others, I think, Mr. Chairman, which you're sponsoring will bring that issue into focus. But, of course, for the American people that may be a very difficult choice.

Mr. VOLKMER. I thank the gentleman from Oregon. If other members have prepared remarks, they will be inserted in the record at this point.

[The opening statement of Mr. Harris follows:]

OPENING STATEMENT OF HON. CLAUDE HARRIS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ALABAMA

Mr. Chairman, I would like to thank you for reintroducing this important piece of legislation. The effects of pollutants on forests is of particular interest to my district and to Alabama. Both the forestry and the coal industries contribute significantly to the local economy. Furthermore, damage to our private and public forests is a national problem.

To solve this problem, we need accurate information. Unnecessary delays in determining the consequences of man-made pollutants on our environment will hamper efforts to guard against it. With its emphasis on understanding the interactions between acid precipitation, air pollutants, and other factors, this bill will add to the current work being done on this project. Speeding up the research effort in this area will help us in finding a solution as quickly as possible.

Mr. VOLKMER. Our first panel is Mr. George Leonard, Associate Chief, Forest Service, Department of Agriculture. He is accompanied by Dr. Charles Philpot, Associate Deputy Chief of Research, the Forest Service. We also have Mr. Donald Ehreth, Deputy Assistant Administrator for Research and Development, from the Environmental Protection Agency. He is accompanied by Dr. Courtney Riordan, Director of Acid Deposition, Environmental Protection Agency.

Gentlemen, your statements will be made a part of the record, and you may either review them in full or summarize.

We will begin with Dr. Leonard.

STATEMENT OF GEORGE M. LEONARD, ASSOCIATE CHIEF, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. LEONARD. Thank you, Mr. Chairman, members of the subcommittee.

The Forest Service has always been concerned about the health of our Nation's forests. Historically we have focused our concern on such agents as insects, disease, fire, and drought. However, in the 1960's we became concerned about environmental pollution, especially air pollution, as a potentially damaging influence on our Nation's forests.

In the early days of our air pollution research, we conducted studies in southern California and in parts of the eastern United States near significant sources of pollution. These studies focused on the effects on trees of rather high levels of gaseous pollutants such as ozone in southern California and sulphur dioxide in the East.

As a result of this research, we have learned much about how trees respond to high levels of gaseous pollutants. We know that some species and varieties are more susceptible than others, and we know that trees have been weakened and the forest has been changed in the San Bernardino Mountains of California as a result of exposure to ozone.

During the past 10 years, our concern about airborne pollution has broadened. The acid rain issue has made us realize that air pollution is not only a problem near the sources of pollution, but is also a problem in rural areas far from the original sources. Therefore, it is possible that the health of our forest ecosystems over vast, remote regions may be affected.

We have several reasons for our concern. We know that airborne pollution is present at elevated levels even in remote areas. This includes acid rain, other forms of acidic deposition, and toxic gases such as ozone. We know that forests can be very efficient receptors of air pollutants because trees have a large area of contact with the atmosphere.

Some forests such as the high mountains of the Appalachians are in frequent contact with polluted clouds and precipitation containing high contaminant levels and are, therefore, susceptible to damage and declining growth.

Recently in central Europe, as Mr. Smith has pointed out, several forest types have shown symptoms of general forest decline. It appears likely that this condition is at least partly a result of high levels of air pollution in central Europe.

High elevation spruce and fir forests in the eastern United States have shown symptoms of needle loss, discoloration, and increased mortality. Although we have learned that these forests receive relatively high levels of air pollutants, we have no conclusive evidence that air pollution is causing these problems.

Several species of pines in the Southeast have shown decreased growth rates in natural stands during recent decades. The reasons are not known, but the growth reduction does not appear to be the result of changes in tree age or stand density.

These observations leave us with important questions: is air pollution causing adverse changes in forest health over broad areas of the United States and, if so, what components of air pollution are involved?

To help address these questions, the Forest Service began a greatly expanded program of air pollution research in 1985 under the auspices of NAPAP, the National Acid Precipitation Assessment Program. From the onset, we have planned, funded, and implemented this program cooperative with the Environmental Protection Agency. We believe this is one of the truly successful interagency research programs under NAPAP.

The forest industries also participate in this research program through NACOPASI, the National Council of the Paper Industry for Air and Stream Improvement. We are conducting cooperative research programs focused on four broad forest regions: the eastern spruce-fir forests, the southern pine forests, eastern hardwood forests, and the western conifer forests. Forest Service and EPA personnel are participating with many State, private sector, university, and international scientists in the conduct of this research.

In our current program we are studying hypotheses of air pollutant influences on trees and forests. We are conducting surveys of forest conditions, running statistical studies of forest conditions in relation to existing levels of pollution, implementing controlled field studies to determine if various species are affected by known levels of pollutants, conducting controlled laboratory studies to understand the mechanisms through which pollutants affect trees, and modeling studies to help understand how entire forest stands might respond to air pollution stresses.

Results from all these studies will be necessary to state with confidence that air pollutants are, or are not, adversely affecting our forests. By the early 1990's, we will begin to have answers to these studies. We will understand much better the relative sensitivities of various tree species to regional pollutants alone and in combination, and we will better understand the relationships between forest conditions and current levels of pollutants.

We plan to continue other studies well into the 1990's. These will be the controlled studies that will lead us to an understanding of the cause and effect of relationships between air pollutants and trees in forests. We will also continue our observations of forest conditions to determine if changes are occurring in response to changing levels of pollution or other stresses.

Finally, we are planning for an expanded research effort that will enable us to study the response of the forest to a wide range of atmospheric stresses, including pollutants, climate changes, and altered levels of carbon dioxide.

Specifically, concerning H.R. 2399, we do not believe this bill is necessary. The Forest Service has existing authority to conduct a long-term program of research on the responses of forest ecosystems to atmospheric influences. However, the bill is certainly consistent with our plans to implement such a program.

Mr. Chairman, that concludes my statement. Dr. Philpot and I will be glad to answer any questions.

[The prepared statement of Mr. Leonard appears at the conclusion of the hearing.]

Mr. VOLKMER. Thank you very much, Mr. Leonard.

Mr. Ehreth.

STATEMENT OF DONALD J. EHRETH, DEPUTY ASSISTANT ADMINISTRATOR, OFFICE OF RESEARCH AND DEVELOPMENT, U.S. ENVIRONMENTAL PROTECTION AGENCY

Mr. EHRETH. Good afternoon, Mr. Chairman.

As you indicated before, I am here to represent the Environmental Protection Agency. I want to emphasize two points. One is about EPA's role in management of the research program on effects of atmospheric deposition on forests and how it's important to tie that program to, or create a policy relevant design of such a program for, an effective forest response program. I'd like to also repeat the message that Mr. Leonard just conveyed, and that is the necessity to continue cooperative efforts of EPA and Forest Service scientists under the current program framework to assure the output of high quality information.

Under the Clean Air Act, EPA has the responsibility for protecting the Nation's health and environment from the adverse effects on air pollution. EPA maintains research programs to determine the direct as well as indirect effects of gaseous pollutants and atmospheric deposition, the wet deposition and dry deposition of gaseous pollutants and particulates on both human health and ecosystems.

EPA has long recognized potential effects of gaseous pollutants on agriculture. We have supported studies to determine influence of ozone, nitrogen dioxide, sulphur dioxide, and hydrogen fluoride alone or in combination on foliar injury and growth of agricultural crops. That project was the National Crop Loss Assessment Network, started in the late 1970's, which was to develop pollutant dose response information for economically important crop species.

As indicated by Mr. Leonard, EPA's concern that ozone might be causing the decline in the San Bernardino National Forests of southern California led to the implementation of the mid-1960's of a large ecological study to determine the nature of that decline. He's already conveyed the results of that study to you.

More recently, EPA funded several pilot studies under the auspices of NAPAP, which brought to light the decline occurring in high elevation spruce and fir forests in the eastern United States. As a result of EPA's experience and expertise, the agency provides capability that is unique and essential to the management and implementation of a responsive program to determine the effects of atmospheric deposition on forests.

Since 1980 we have been working jointly with other Federal agencies in planning and implementing NAPAP, the acronym for the National Acid Precipitation Assessment Program. The research program is aimed at providing answers to the scientific questions that are most relevant to the establishment of policy on the issue of acid deposition.

Mr. Leonard indicated that both the Forest Service and EPA have jointly developed and implemented a forest response program, and we share the unified goal to determine, one, if atmospheric deposition is causing or contributing to forest damage in the United States and, if so, what are the causes and mechanisms and, finally, what are the dose-response relationships between forest damage and atmospheric deposition.

Coordination of such a major research effort is assured by the national program management, an executive oversight panel, and a central synthesis integration and data management team. This organizational structure includes representatives from both the Forest Service as well as EPA.

The accomplishments of our efforts to date include establishment and characterization of five high elevation and on low elevation spruce-fir sites; the first year of data on the exposure of high elevation of spruce-fir forests to clouds and the characterization of high elevation deposition chemistry; one full season of controlled exposure data in several northeastern, southeastern, and western tree species; extensive analysis of growth patterns and low elevation red spruce; compilation of atlases containing past climate, soil, tree speciation, and chemical climatological data for the Southeast and the implementation of a similar project for the Northeast; survey of forest conditions in Pennsylvania and Michigan and Minnesota; and the implementation of projects which will allow the extrapolation of specific mechanistic research to a regional assessment of the effects of acid deposition and associated pollutants of forest health.

I want to stress the fact that these are results from the first year of activity under this joint arrangement between the Forest Service and EPA. I also want to stress that the forest response program has been designed to make the most of the expertise that resides in both the Forest Service as well as EPA.

If the program has been designed by one of the agencies alone, whether it be EPA or the Forest Service, it probably would not have been as effective. I believe that we have created a program of the highest scientific quality that is responsive to the research needs of policymakers.

What do we expect in terms of near-term results? Within the next one to two years the forest response program will make much progress we believe toward answering such policy questions as: is there a problem due to acid deposition in forests and associated pollutants in forests and, if so, what are the mechanisms and the dose-response relationships?

Consequently, we expect results of our screening studies for susceptibility to acidic deposition and other air pollutants in spruce-fir. We expect determination of the most plausible mechanisms of the effects of acid deposition for air pollutants on spruce-fir and southern commercial pine. We expect estimation of the range of forest damage in spruce-fir and southern commercial pines, and, finally, we expect to determine the potential for adverse effects of acid deposition and associated air pollutants on eastern hardwoods and western conifers.

Now, again, I want to stress the fact that we have just had one year's worth of data collection, so we expect these results to appear within the next one to two years.

In conclusion, allow me to emphasize three points that I believe are critical to understand EPA's role in the research program for determining a relationship between atmospheric deposition and forest effects.

My first point has to do with the very essence of the research itself. Research must be designed to address the scientific questions of principal concern to policymakers. The EPA Administrator has been diligent in holding our own EPA research managers and scientists accountable for achieving such a design both within their own programs and in the joint program with the Forest Service. Without that kind of direct line responsibility for performance, a research program can stray from its intended objectives.

My second point is that the EPA has a long and successful history of carrying out research on effects of atmospheric depositions on crops and forests. EPA has accumulated not only scientific expertise, but also research management expertise. The latter is indispensable to the design and the implementation of research programs that incorporate integrated, short-term as well as long-term approaches needed to supply knowledge required for rational development of policy.

And, finally, I have conveyed my own conviction that the research partnership between EPA and the Forest Service will be a great success. The fact is it has already been a great success.

The forest response program has enhanced research in both agencies and quality results will emerge both in the short term as well as the long term. These incremental improvements in knowledge will provide the Administrator of EPA the necessary information as he evaluates the need for additional regulatory actions. Under this program's framework, the NAPAP program framework, both EPA and Forest Service can continue to refine our knowledge of the atmospheric effects as needed. Therefore, we believe that enactment of the bill is unnecessary.

Thank you, Mr. Chairman. That concludes my prepared remarks. Dr. Riordan and I, as well as Mr. Leonard and Dr. Philpot, are prepared to respond to your questions.

[The prepared statement of Mr. Ehreth appears at the conclusion of the hearing.]

Mr. VOLKMER. Thank you very much. I have a few questions.

Mr. Leonard, in your statement you didn't believe that H.R. 2399 is necessary or even desirable. That means to me that you're satisfied with the current research program that's been established; is that correct?

Mr. LEONARD. Yes, sir. The major thrust of the statement was that the Forest Service has a very broad charter under the Forest and Rangeland Renewable Resource Research Act, and that we simply don't need additional authority to carry on this research.

Mr. VOLKMER. Well, the legislation not only provides authority—I have to agree with you that you have the authority, but I believe it also adds a few things. Let me ask you this: under the present program that you presently have in place—now I'm not talking about the big atmospheric NAPAP. I'm not talking about that. I'm talking about your proposal; right?

Mr. LEONARD. Yes.

Mr. VOLKMER. What scientific, outside scientific group do you have place as far as giving you guidance in setting up a program?

Mr. LEONARD. Let me ask Dr. Philpot, who is directly involved in that, to respond.

Mr. PHILPOT. It depends a little bit on the issue being addressed, but we have a system now in place that requires all research plans for all the major components of the program to be peer reviewed. In some cases we use international panels of scientists. The panels may consist of different people for different kinds of needs.

Mr. VOLKMER. I'm only talking about research into effects of ozone or pollutants, whatever, on our national forests. That's the issue here today.

Mr. PHILPOT. That's what I'm talking about.

Mr. VOLKMER. You're talking about peer review as far as reviewing application for grants.

Mr. PHILPOT. No. I'm talking about a peer review system that analyzes and looks at our plans, our research plans, the way we do research, the way we're organized to do this research, how it relates to the policy questions that Congress is asking EPA to address. A whole array of things are being addressed by peer panels, not peer panels in the narrow sense about grants. We do that also in this program because——

Mr. VOLKMER. Let me ask you this: in the legislation that the chairman of the full committee is a primary sponsor on, the first thing we really ask for—I was trying to get it—to establish a 10-year program, and in there we list the things that we want done, the type of things we want done in the program.

Now do you have such a program onboard right now for the one that you're going on?

Mr. PHILPOT. Yes. We have a long-term atmospheric deposition program for U.S. forests, probably beyond 10 years. It's comprehensive in that as we address the acid rain questions, and successfully solve those problems, we'll move into ozone and the other pollutants and hopefully be able to move on into the global climate questions, as George Leonard mentioned.

In fact, if you plot that whole program out, it's beyond 10 years. It's a very long-term, fairly fundamental program.

Mr. VOLKMER. All right. If you review the provisions that are set out in the chairman's bill which are on page 3 and the top of page 4 of the legislation, are there any things in there that would cause any difficulty to your program?

Mr. PHILPOT. No, I don't think any of that would give us any cause for concern. There may be some additional paperwork, but I don't think that's a big concern.

Mr. VOLKMER. Then on page 4 we provide that the committee to advise the Secretary in developing the program shall be composed of scientists, training, experience—the various disciplines, et cetera. You basically already say you've already done that?

Mr. PHILPOT. I think basically we do that, but we do not do it with a standing committee of a certain membership. We do not have that currently. We do that on a rotating basis.

Mr. VOLKMER. Would that cause you difficulty, to do it this way?

Mr. PHILPOT. I don't think it would be particularly difficult for us to do.

Mr. VOLKMER. And would coordinating the program with existing research efforts of Federal and State agencies, private institutes—that's not going to cause you any problems?

Mr. PHILPOT. That's an integral part of the current program, including international considerations.

Mr. VOLKMER. Would submitting the reports that are called for on pages 4 and 5 cause you any difficulty?

Mr. PHILPOT. No, just some additional work.

Mr. VOLKMER. That's my next question, and then I'm going to let somebody else ask questions, and then I'll come back on my time.

It bothers me—have I seen or has anybody here in the Congress seen a report on the present program that you are operating under?

Mr. PHILPOT. The output of the current program has been reported to Congress through the annual reports of NAPAP. We have not yet produced a specific report of the forest response program, but we are planning to do so.

Mr. VOLKMER. Forget NAPAP because I don't think NAPAP is—it's too specific, too narrow a focus as far as I'm concerned. It's more acid deposition. Am I wrong on that?

Mr. PHILPOT. That's basically correct.

Mr. VOLKMER. Is that correct? Dr. Ehreth, do you agree?

Mr. EHRETH. I would just add to Dr. Philpot's statement that the program focus is multipollutant. It's not just simply sulphur oxides and nitrogeous oxides. It is multipollutant. Would you agree with that?

Mr. PHILPOT. Yes, but I'm just saying its focus has been——

Mr. EHRETH. The focus is on acid deposition; you're right.

Mr. VOLKMER. Right; it's narrow and I want more broad. That's why I don't believe that NAPAP is going to fulfill what some of us want to be looked at.

Mr. EHRETH. Do you mind if I try to respond to part of that?

Mr. VOLKMER. Yes, go ahead.

Mr. EHRETH. I think it's a matter of degree. I believe that it's broad in the sense that you're looking at the interaction between natural stress factors as well as atmospheric pollution problems. That can be as broad as one would want to define it because you quickly develop a mountain of questions that one has to address to answer—to determine whether or not either one of those two is the most critical unknown in the equation.

Depending on whether or not you're including in your definition of "broad," productivity and things of that nature to enhance productivity, certainly the NAPAP plan does not go into that.

Mr. VOLKMER. I think that's very important for the future, as far as I'm concerned, of this country and our forests and supply of forest products—not just the one area, but to look at the total regeneration, total growth, and those things of things are just as important.

Mr. PHILPOT. I think it would be correct to say that Congress is currently not receiving a report that is that comprehensive.

Mr. VOLKMER. No; and we haven't gotten any report yet on the work that you're doing under your existing research outside NAPAP; right?

Mr. PHILPOT. Not in one place, no.

Mr. VOLKMER. Well, my 5 minutes has expired. I'll now recognize the gentleman from Washington.

Mr. MORRISON. Thank you, Mr. Chairman.

I have to comment that I'm delighted with the cooperative effort that we have represented in this panel. I might ask, Mr. Leonard, you're an authority, of course, who comes from a rather broad authority provided for the U.S. Forest Service. I presume, Mr. Ehreth, that under the Clean Air Act that you're given broad authority to look in a variety of areas. Did this cooperative effort—where was it initiated? How did it start?

Mr. EHRETH. It was initiated through the formation of the National Acid Precipitation Assessment Program, and there was an interagency agreement entered into between the two programs when it was recognized that the forest impacts were potentially quite important in the equation of developing policy with regard to controlling acid rain.

Mr. LEONARD. I think it is fair to add, though, that the cooperative relationship between the Forest Service and EPA predates NAPAP. As we have both indicated in our statements, some of the early atmospheric research concerned with the health of the forests down in southern California was a cooperative effort.

Mr. EHRETH. That's a good point—early in the sixties.

Mr. MORRISON. I presume since you started that, your feeling is that's a healthy relationship for you. Do they get in your way at all or are you able to make more progress because of that cooperative effort?

Mr. **Leonard**. Perhaps Dr. Philpot, who has been involved over time, would like to answer. But my observation is that we can capture the strengths of both organizations this way. Obviously, any time you coordinate it takes an effort to accommodate, and sometimes there's some disagreement between the agencies as to approaches. But, overall, the Forest Service has some strong resources in this area; EPA has complementary resources. I think together we have a better program.

Mr. **Morrison**. A question on funding: I presume, then, that this is not a line item within the Forest Service budget, or is it?

Mr. **Philpot**. No. The money for this program from the Forest Service side is taken out of five line items.

Mr. **Morrison**. Under EPA, this is not a specified item?

Mr. **Ehreth**. My understanding is that there is about $20-million program right now. I believe, if I am correct, Dr. Riordan, it's about $11 million in EPA and $9 million in Forest Service, or is it the other way around?

Mr. **Riordan**. That's right.

Mr. **Ehreth**. For EPA $11 million and $9 million for Forest Service. And then there's even exchanging of resources within our own direct appropriations.

Mr. **Morrison**. Is that adequate for the job we have to do?

Mr. **Ehreth**. Well, it certainly has grown tremendously in the past couple years. As I recall, about 2 years ago it was in the neighborhood of about $2 or $3 million, and you can only handle growth at a certain rate, and that's pretty fast growth.

Mr. **Morrison**. I notice, Mr. Leonard, in your comments the statement, "Presently, with the exception of demonstrated ozone damage to forests in California, there is insufficient data to conclusively state that atmospheric deposition is or is not causing adverse effects in U.S. forest conditions."

That's as far as you can go as far as a definitive statement is concerned?

Mr. **Leonard**. I think that is accurate; yes, sir.

Mr. **Morrison**. Yet we know we've got a problem out there?

Mr. **Leonard**. Very definitely.

Mr. **Morrison**. You're just not sure how it all adds up?

Mr. **Leonard**. That's correct. It's a very complex biological situation, and our best estimate is that there is no single cause; it's a combination of the various atmospheric pollutants interacting with the biological community in different ways—in specific locations.

Mr. **Morrison**. I think the program is moving ahead rather well. I would make a comment—not in the form of a question—to you: I know you question the reasoning behind this legislation. I guess I've got a theory that says you can go ahead and do your own thing, and that's fine. I respect you for doing it in the cooperative effort between the two agencies.

I also know that there is a need for some support and understanding. If this legislation, even if modified, Mr. Chairman, could add to that support and understanding among Members of Congress that here are two agencies working together to address a problem that we see to be wrestling with in other arenas and not making much headway, that that probably is to your benefit.

We certainly will hope that if we move that legislation along—and probably will—that it can be done—that it will only be positive from your point of view. Even though I think your observation is you don't need it at this point, I think after a few years you probably will.

I will yield back, Mr. Chairman.

Mr. **Leonard**. It's certainly safe, Mr. Chairman, to say that the Forest Service, and I'm sure EPA, appreciate the attention that this committee has given to this issue, and we all share your concerns about the health of these forests.

Mr. **Morrison**. Thank you.

Mr. **Ehreth**. Could I add a comment to that, too, Mr. Morrison?

Mr. **Morrison**. Certainly.

Mr. **Ehreth**. I think there's a difference between stating a bill is unnecessary versus stating that we oppose a bill. It's important to make that distinction. The point that we are suggesting, both of us, is that we'd like to proceed forward in a cooperative manner. Consequently, if there is such a bill reported out of committee, we'd like to see that continued cooperation so indicated in the bill, because the current framework has proven to be successful and, quite frankly, we've learned—EPA in this case must say that we have learned from the Forest Service how to conduct a joint or an interagency activity. They have proposed the process and the management structure, and it's worked very, very effectively.

Mr. **Morrison**. We certainly would like to add to that effectiveness as opposed to getting in its way.

Let me tell you in this process just a word of advice: if you can help Chairman de la Garza get a bill out on this forest productivity issue, he's going to talk about it all over the world and it's going to be to your benefit. I think we can all work together and advance this cause, maybe a little ahead of ourselves, but let's work on it together.

Mr. **Volkmer**. With that, I would like to recognize the chairman of the full committee, who is the primary sponsor of this legislation, for any comment he may wish to make at this time.

STATEMENT OF HON. E (KIKA) de la GARZA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS

The **Chairman**. Thank you very much, Mr. Chairman. I apologize for being late. I was held back in the other subcommittee working on the Farm Credit System, and I apologize.

I read both of the gentlemen's statements. I'm not terribly excited over them, but I've heard piecemeal.

Then I had to leave to go to the floor. We had some very important legislation on the floor and they adjourned before we could get there. We're trying to pass legislation recognizing the importance of dairy goats in our society, Dairy Goat Awareness Week for next week. They adjourned before we could get there. We'll do it in the morning.

This is just as important an issue, though. I think we're all going in the same direction, but you have a different viewpoint from your perspective and we from ours. After hearings that we had last year, we passed the legislation, and similar legislation last year passed the House; some of us attended the World Forestry Congress in Mexico City. I have visited with forestry experts in Brazil, in Germany, here in the United States, in the Po Valley in Italy, in France, in Canada. I still feel that somehow we are directing our effort toward acid rain.

Most of the research, even the NAPAP or the National Acid Precipitation—even the name gives that. I think that this program has been hindered by a very narrow focus. As an aside, they say "and other pollutants."

This is what we'd like to do: with all due respect to the EPA—and the EPA is just as integral a part of agriculture with FIFRA and all of the other related areas that we have to work; it's just as important a part of agriculture and to this committee as any other—the lead expertise is in the Forest Service. You can't get away from that. We'd like to have the Forest Service be the leader.

I just read—I don't remember if it was the New York Times or the Washington Post—a week ago or last week, they even showed pictures of the forests and the ozone. That's getting to be quite a dangerous zone. With all due respect, the answer is not wearing sunglasses and a hat.

We have no expertise beyond what we're able to develop ourselves by bringing in experts such as you and your peers, by speaking with experts, and by having other people do research. We have no in-house ability for research. We have to rely on GAO. We have to rely on other agencies: Technology Assessment.

We think that this legislation is needed. We think that it will not detract from anything you do. We think that it will complement, but we've got to get the necessary information about air pollutants in the forest ecosystems because I don't think it's acid rain in Brazil and some of the areas in darkest Africa. Somehow it has become a catch phrase, a media phrase, a too-easily-identifiable phrase I guess, this acid rain. Our Presidents met, Canada and the United States, to talk about acid rain. It maybe could have been something in the ground. It could have been an insect. It could have been a fungus. We don't know. But something else is polluting the forests of the world besides acid rain. We need to have the scope of it.

This is very modest because we don't have the unlimited resources. We need to get the scientific experts in the field to work.

I'm glad to hear that you feel it isn't needed because you think you're doing what needs to be done, but we don't seem to think that you're covering fully the area. The mandate may not be there under the existing legislation. This broadens the mandate and changes not the direction, but changes the lead somewhat and what we want done. I think it's as simple as that.

Thank you, Mr. Chairman.

[The prepared statement of Chairman de la Garza follows:]

STATEMENT OF THE HONORABLE
E (KIKA) DE LA GARZA, CHAIRMAN
COMMITTEE ON AGRICULTURE
REGARDING H.R. 2399,
THE FOREST ECOSYSTEMS AND ATMOSPHERIC POLLUTON RESEARCH ACT OF 1987

Mr. Chairman, I want to thank you for convening this hearing to consider the effects of air pollutants on forests, and the bill that we have cosponsored, H.R. 2399, the "Forest Ecosystems and Atmospheric Pollution Research Act of 1987.

As you are aware, this bill is identical to one which passed the House last year, H.R. 2631, that was introduced by our former colleague, Congressman Charlie Whitley and the Ranking Minority member of this subcommitee, Mr. Morrison. That bill arose from public hearings of a little more than a year ago that identified a number of inadequacies in current research on the effects of acid rain on forests. During a full day of hearings, the Subcommittee heard from scientists from Europe, Canada, and the United States. These experts expressed concern for the effects of air pollutants on forests, including but not limited to acid rain. Researchers familiar with the rapid decline of German forests discussed efforts to identify the causes of "Waldsterban" or "forest death". Canadian scientists discussed similar efforts to determine the factors surrounding the decline of sugar maples in eastern Canadian as well as the rapid increase in soil acidity in certain regions of the country. Finally, American researchers reviewed current research efforts to determine the effects of various air pollutants, particularly ozone, on U.S. forest ecosystems. Representatives from the USDA Forest Service, the Environmental Protection Agency, and the National Acid Precipitation Assessment Program testified at length regarding their efforts to determine if and how acid rain is impacting trees in the United States.

Several things became clear following this day long inquiry. First, there is a substantial decline in some U.S. forests -- particularly high elevation spruce and fir forests and the productivity of pine forests in the Southeast. Thus far, the causes for these diebacks and declines remain unexplained. However, researchers could not rule out acid rain as a culprit.

Second, acid rain is not the only pollutant that we need be concerned about. In fact, more substantive evidence exists to indict ozone as a cause for both crop and forest dieback. For crops, estimated damage due to ozone is said to amount to $2 billion annually. And that was only for 6 crops that were the focus of the study. Another pollutant of concern was heavy metals, such as lead and zinc, which are known to cause substantial forest diebacks in sufficient concentrations. It became clear from the testimony provided that we cannot look at acid rain in isolation if we are to deal with the problem of declining forest health.

The third conclusion I believe that could be reached by as a result of last year's hearing was that there is an extensive research program in place, set up by the Acid Precipitation Act of 1980, to determine how acid rain if affecting forests. NAPAP -- the National Acid Precipitation Assessment Program -- is the coordinating body for this research which involves Forest Service, EPA, and forest industry researchers. However, this research program has been hindered by its narrow focus on acid rain and has thus far failed to provide the necessary findings to guide policy-makers in dealing with the problems of air pollutant effects on forests.

Given that these same concerns for the effects of air pollutants on forest ecosystems remain, I felt it necessary to reintroduce this bill. Seventeen Members have joined me in cosponsoring the bill -- H.R. 2399 -- including the Chairman and Ranking Member of this Subcommittee as well as the ranking Member of the full Committee, Mr. Madigan.

In brief, H.R. 2399 would establish a ten-year research program to study the effects of air pollutants on forest ecosystems. It would permit researchers to follow the research where it leads them, not restrict them to focus solely on acid rain. The bill would make the Forest Service the lead agency to develop this research program, aided by a committee of scientific experts in the field. Finally, the bill would require that the Forest Service generate a series of reports on the research program, including an initial report that spells out the kinds of research to be done and an estimate of the funds needed to do it. An annual report as well as a final report would also be required to bring the Congress up to speed on what the researchers are learning and to provide some basis for making rational policy decisions to deal with air pollutants that may be having a detrimental effect on forests.

I believe, as I did last year, that this bill is necessary to get the air pollutant and forest ecosystems research program on firm footing and headed in the right direction in order to assure that we ask the right questions and develop the scientific answers to properly develop policies for controlling harmful air pollutants. I look forward to hearing from the witnesses before the Subcommittee today and want to thank you again, Mr. Chairman, for promptly convening this hearing.

Mr. **Volkmer**. Thank you, Mr. Chairman.

The Chair will recognize the gentleman from Alabama.

Mr. **Harris**. Thank you, Mr. Chairman.

Let me go on record at this time to state my full support of our chairman on the Dairy Goat Awareness Week.

Also, I would like to offer an opening statement that I have for the record.

Mr. **Volkmer**. It will appear in the record immediately following the statement of the gentleman from Oregon.

Mr. **Harris**. Thank you.

Mr. Leonard and Mr. Ehreth, did I understand that the biggest cause of concern that you have is that you just feel that what this bill sets out, that it's just merely a duplication of the efforts that you already have ongoing?

Mr. **Leonard**. I think that's accurate, Mr. Harris. We think it doesn't provide us additional authority. It gives us some focus in direction, but we do have the authority to do the research. With the indications from the committee, we'd be moving in that direction anyway.

Mr. **Harris**. Let me ask you this: are you doing it now?

Mr. **Leonard**. I think it's accurate to say that most of that work is either underway or planned; yes, sir.

Mr. **Harris**. Do we have any program of exchange between our country and, say, the European countries? I know that they have a big problem over there. Are we swapping information, what we're gathering, what they're gathering?

Mr. **Leonard**. A very substantial program. Let me ask Dr. Philpot, who has made several trips to Europe, to outline some of the work.

Mr. **Philpot**. We have a formal agreement with the Federal Republic of Germany to share scientists, put scientists in each other's labs, and share studies on air pollution relationships with forests. We also have those kinds of agreements with other countries. We just started a big program with Canada this spring on sugar maple decline in the northeastern United States and southern Canada. We consider that a very important part of this research program.

Mr. **Harris**. Well, I know—and I speak for several folks on the committee and we share a lot of mutual concern about the problem of our forests and certainly want to do what we can.

I know in our State we've got enough problems now with the pine beetle and cutting more than we're growing, to have other causes of concern as far as destroying our product, our forestry situation.

I would hope that as the legislation moves, as I know you will, that we will have your cooperation in working toward a settlement of this problem.

Mr. **Ehreth**. Mr. Harris, I think it's important to note—and I think my colleagues from the USDA are being overly polite and cordial here, but they do have the lead responsibility under the current NAPAP structure for the forest response program, and they're doing a very able job in that regard.

I think the point that we're stressing is that we would want to see any kind of legislation continue that arrangement that we've been able to implement. I think it's been successful. We can point to projects—Mr. Leonard pointed to them in San Bernardino; we can point to an aquatic survey project earlier in the eighties out in the West; and now, most recently, with the forest response program. There's been a very, very good interaction between the two agencies. We would not want to see that sort of arrangement dismantled.

Mr. **Harris**. Don't you see this as being in addition to what you're already doing?

Mr. **Ehreth**. Well, I think the subtlety between what I hear being said by the committee members and what I've read into the bill, and what we're doing, is we are looking at specific forests with regard to dose response, trying to determine that relationship between what do the atmospheric pollutants or the natural stress factors create or cause in terms of forest declination or damage. In our NAPAP program, I would say it's safe to say, we are not looking at the overall forest resource picture as the chairman had suggested that he would like to see done.

Now whether or not the bill captures the entire forest system as a resource, I'm not sure. My colleagues from USDA might be more able to respond to that particular issue.

But I have here—and I'd be happy to leave with the chairman—the copy of the responses of forest atmospheric deposition national research plan for the forest response program, which incidentally does identify, as my colleagues have said, a program very similar to the program you outline in your own bill.

Mr. **Harris**. Well, I share the same concern as the chairman does because we have a lot of coal mined in our area, and everyone focuses on acid rain and blames the burning of coal. I don't think that anyone wants to intentionally destroy our forests, but we do need to have as much research as we can to find out where the guilty culprit is or what it is.

Mr. **Ehreth**. That's exactly right.

Mr. **Harris**. Thank you, Mr. Chairman.

Mr. **Volkmer**. The Chair now recognize the gentleman from Louisiana.

Mr. **Holloway**. Mr. Chairman, I first would like to compliment my colleague from Alabama on the fine field hearing we had down in his State last week. You joined us, Mr. Chairman, and we had really a fantastic hearing there.

At the hearing, a Forest Service employee said he feels there has been a decline in the growth rate of the southern forest timber. That disturbs me because it is not easily observable. If you see dead trees killed by pine beetles or acid rain, you know there's a problem, but the average person does not realize there is a problem if we just have a slower growth rate. It looks like genetic improvements in trees would result in a greater growth rate. If you have any information on what's causing it, we'd be very interested.

I've already cosponsored this bill, and have just one question for you related to it. Is any additional funding required if this bill becomes law?

Mr. **Leonard**. Mr. Holloway, I don't believe that it would require additional funding. The program has the potential to continue building. As we find out more about the mechanisms by which these pollutants are affecting the forests, it has potential to grow, and we'd be prepared to come back and ask for that additional funding.

Based on what we know today, we're probably at the level we should be operating.

Mr. **Holloway**. Thank you. I have no further questions, Mr. Chairman.

Mr. **Volkmer**. I have a few other questions. I'd just like to clarify something for my own mind and also, I believe, for the record.

Mr. Leonard, the way I understand it right now, we have two programs ongoing within USDA. Now you correct me if I'm wrong on this. One is the program established, and you're in charge of the terrestrial part of the NAPAP; is that correct? That's working with EPA and NOAA and everybody else on that.

Mr. **Leonard**. Correct.

Mr. **Volkmer**. The second one is the forest response research program; is that correct? I am correct on that?

Mr. **Philpot**. I think that's possibly where the confusion arises. Almost all the air pollution research currently being done in the Forest Service, including the forest response program with the EPA, is part of our NAPAP program.

Mr. **Volkmer**. It's all part of the NAPAP program?

Mr. **Philpot**. Yes. It's under the NAPAP umbrella.

Mr. **Volkmer**. Well, see, that's where some of us have a little bit of confusion.

Mr. **Philpot**. I understand, yes.

Mr. **Volkmer**. Also we think that that's not broad enough again. You understand where we're coming from?

Mr. **Philpot**. I understand, yes.

Mr. **Volkmer**. So any reports or anything that would come to us from that would actually be something through NAPAP?

Mr. **Philpot**. Yes, that's basically been true, except we do have plans now to prepare a comprehensive report on forests from the forest response program written by EPA and the Forest Service together. It should come out in September 1987, the end of summer.

Mr. **Volkmer**. OK.

Mr. **Philpot**. That will not be a NAPAP report. That will be just a report on the forests from this program.

Mr. **Volkmer**. Fine. I'd appreciate that.

Now next what I want to point out is that, Mr. Ehreth, in 1990 NAPAP expires; correct, our existing law?

Mr. **Ehreth**. Correct.

Mr. **Volkmer**. What does that do to you, Dr. Philpot?

Mr. **Philpot**. We were asked by OMB a year ago and we have support in the Department of Agriculture to define our research needs beyond 1990 in the area of air pollution in forests and air pollution in crops, with the additional request that that be a comprehensive look at the whole problem and not be focused on just acid rain.

We feel right now we've gotten both the administration and the Department behind us on continuing on past the 1990 sunset of NAPAP. Those plans have been described and are in place.

Mr. **Volkmer**. Doesn't that do what H.R. 2399 does?

Mr. **Philpot**. I think it's parallel with that, yes.

Mr. **Volkmer**. Basically aren't we saying the same thing?

Mr. **Philpot**. Basically, yes.

Mr. **Volkmer**. The other thing that concerns me, you may start down this road broader in general and, as we all know, with some changes sometimes in the administration and things some of those things change, priorities change, whatever have you. But if we had the legislation on the books, basically it's more apt to be there as a permanent fixture at least for the 10 years of the life of this bill than if we don't have it on the books. That's the way some of us in the Congress like to look at these things.

I'm not saying that you wouldn't do it, Dr. Philpot; I don't know. I don't know if you would control it as much as would be done if we had the legislation.

That brings me back to the reports again now that I've got that cleared up. Mr. Ehreth, let's see, we were supposed to have a report on NAPAP—what—from the assessment from 1985?

Mr. **Ehreth**. Yes, except that—yes, I will answer that question, yes, there was supposed to be a 1985 assessment.

Mr. **Volkmer**. And this is 1987?

Mr. **Ehreth**. Yes, but, again, there's a director of research that has a principal responsibility for producing that report and, as you indicated in your opening statement, he declined to testify today. But I can assure you that we are very conscious of the fact that that report is overdue, and I don't believe any of us here at the table are very happy about that.

Mr. **Volkmer**. Now it was just last year when OMB, Dr. Philpot, said, "Let's get online with doing a forest response research program that is broader than NAPAP;" right?

Mr. **Philpot**. Yes; and beyond the timeframe.

Mr. **Volkmer**. I'm just curious about—can you tell me about what time of the year that was last year?

Mr. **Philpot**. That was during our NAPAP OMB hearings examination. It would be about last September.

Mr. **Volkmer**. It would be last September?

Mr. **Philpot**. Yes.

Mr. **Volkmer**. About the time that a bill almost identical, if not identical, to this bill was passed in the House?

Mr. **Philpot**. Pretty close.

Mr. **Volkmer**. Pure coincidence, of course. [Laughter.]

Well, let's see if I have anything else. Mr. Ehreth, how much—strike the "how much." Let's put it this way: under NAPAP are we increasing the amount of research being done on the effect of ozone on our crops and our vegetation, our forests, or are we decreasing the amount of research that's being done on that at the present time?

Mr. **Ehreth**. Under NAPAP we look at the effects of sulphur dioxide, ozone, nitrogen dioxide, and several other pollutants—all in combination—and try to isolate which pollutants or combination thereof are the most important.

However, under our base program, under our appropriations and our other authorization that we have under the Clean Air Act, we have a research program directed specifically at looking at the effects of ozone on forests as well. That program has moved from crop-related effects, that national crop loss assessment network I described earlier in my testimony—and moved its focus to the effects of ozone on forests. The two programs complement each other. They're conducted by the same laboratory, basically the same research scientists. Consequently, both the Forest Service and EPA enjoy the benefits of that collaborative undertaking.

Mr. **Volkmer**. Mr. Leonard, is the National Vegetation Survey in place?

Mr. **Leonard**. Yes.

Mr. **Volkmer**. Is that correct?

Mr. **Philpot**. I didn't understand the question.

Mr. **Volkmer**. The National Vegetation Survey.

Mr. **Philpot**. Is it in place?

Mr. **Volkmer**. Yes.

Mr. **Philpot**. As a survey it's not in place, but the program is in place.

Mr. **Volkmer**. The program is in place——

Mr. **Philpot**. Yes. Through the forest response program. It's one of the components of the forest response program. The only survey activities it's doing now are surveys trying to relate effects to deposition gradiants. In other words, looking at forests over large pollution gradiants, but we have not designed the survey yet because we still haven't found any specific effects of acidic deposition on forests. Until we can do that, we've kind of held back on implementing the survey per se.

Mr. **Volkmer**. Is there any timeframe in which you feel that you will be able to develop your survey?

Mr. **Philpot**. We're not sure that we can give you the exact timeframe, but we have a plan in place now to develop a long-term forest health monitoring system for this country, for the whole United States, and we think that may be the final outcome of the survey activities. Periodically we would go out and measure forest health on a comprehensive basis, just like we do timber supply, and do it for all U.S. forests. We have people right now trying to design such a system.

Mr. **Volkmer**. It would be impossible for you to furnish us with any data on that, then, would it?

Mr. **Philpot**. We could give you a series of reports that have come out from that survey on, for example, the extent of spruce mortality in the New England States. We could get you that, lots of statistics on how many spruce trees are dying—not saying why they're dying—but where they're located. We have some surveys on gradiants that we could give you. We can give you that kind of thing, but we cannot give you any kind of a survey report that this is the change in U.S. forest due to deposition over, say, a 10-year period, like the Germans are doing, because we don't have those symptoms to measure yet.

Mr. **Volkmer**. Change in nutrients in the soil or anything else—we don't know.

Mr. **Philpot**. We don't know that; right.

Mr. **Volkmer**. We don't know what it is? OK.

We have some additional members here. The gentleman from California.

Mr. **Panetta**. Thank you, Mr. Chairman. I apologize for arriving late.

I assume that one of the recommendations is to put sunglasses and umbrellas over our Nation's forests; is that right?

Mr. VOLKMER. That's been commented on by the chairman.

Mr. PANETTA. Good. All right.

Let me ask you Mr. Ehreth, how serious a problem do you think this is?

Mr. EHRETH. Certainly the evidence, as indicated by Mr. Leonard and by my own opening testimony, indicates that there is definitely a declination and dieback of forests in the country. The problem is we don't know what to pin it on yet.

For instance, if somebody said today, "Let's pin it on sulphur," and we proved to you within a year or two from now that it's not sulphur, somebody is going to have to go out there and spend billions and billions of dollars putting flue gas desulphurization scrubbers on virtually every public utility or a good number of them across this country. This research program has just had one year to get started or one and a half years, something of that nature. So there are some very important questions remaining to be answered.

Mr. PANETTA. At this point does the evidence indicate a relationship?

Mr. EHRETH. The evidence points to interaction between pollutants, rather than pointing to one specific pollutant. Quite frankly, with just having the data collected and the data not being assessed or analyzed fully yet, and not having gone through peer review, it is very difficult for me to say that oxone is the problem or ozone is the problem, or sulphur is the problem or ozone and sulphur, that sort of thing. I just can't say that to you at this time.

Mr. PANETTA. Can I ask you whether you think there's a relationship?

Mr. EHRETH. Yes, I think there's probably an interaction, as indicated by previous studies. When the ozone affected certain forest stands, it made them more susceptible to disease or to effects related to bugs or aphid-like bugs and some of the beetles. I think there's interaction. Again, it's difficult to say which of the pollutants we should be focusing on.

For instance, if it were ozone, controlling sulphur with flue gas desulphurization, simply wouldn't get you there. It would be a waste of money.

Mr. PANETTA. Do both of you feel that at some point you've got to undertake a comprehensive study that looks at both acid rain and ozone impacts, as well as other pollutants, as they relate to our forests? Is that your view?

Mr. LEONARD. We think that we have that comprehensive study underway and that in the early 1990's we will be able to respond with very good data to the kinds of questions you're asking.

Mr. PANETTA. I guess my only concern—and I think it's probably been raised here earlier—is that when a study begins focusing on acid rain and you try to expand it to other areas, I have found that you run into a tremendous amount of opposition from people who thought that the study was focused on one element and suddenly it focuses on other elements, which prohibits the people doing the study from ultimately expanding it. I guess that is what concerns me in terms of the effort to expand this particular study.

Mr. **Philpot**. One of the things we've required of most of our studies in the forest response program, the one that's sponsored by EPA and the Forest Service, is chamber studies. We treat tree seedlings in controlled chambers to an ozone treatment, a sulphur dioxide treatment, and an acid rain treatment either alone or in combination. This is done wherever it's feasible to do with the equipment available.

Most of our "acid rain studies" that you see in print also look at the effects of photo-oxidants and sulphur dioxide gases as well as in some cases drought and other possible interactions. Sometimes the writeup may look a little narrow to you, but if you look at the research itself that's going on in the labs and out in the field, it's much more comprehensive than that.

Mr. **Panetta**. From my own personal experience in the bureaucracy and having seen it from this perspective, the problem is, unless you have clear direction to expand a study, you're going to have jurisdictional battles between the various agencies who are trying to determine who has jurisdiction over what element.

To some extent, the GAO report confirmed that there's disagreement among NAPAP's various agencies concerning the director's emphasis on ozone research. Since EPA and the Forest Service already have ozone research programs, representatives of these agencies have questioned whether NAPAP should expand its research to include ozone, et cetera.

I'm not surprised by this because that's what we run into whether it's nutrition or any other issue—you run into a battle over who's doing what to whom. That's why I sense the need for Congress to make a clear statement that this kind of broad research needs to be done in all of these areas and to set a mandate so that we don't have problems with interagency jurisdiction in terms of what the study will focus on.

It could take years of fighting these kinds of battles to reach that point. That's one of the reasons I see the necessity for the legislation.

Having said that, I yield back the balance of my time. Thank you, Mr. Chairman.

Mr. **Volkmer**. The Chair recognizes the gentleman from Virginia.

Mr. **Olin**. Thank you, Mr. Chairman.

I don't want to go over the same ground. I apologize for having been in and out during the testimony; I didn't hear most of it.

Following along the same lines of the gentleman from California, it seems to me we had a hearing here last year about a year ago of this same nature. If I remember the conclusions of that correctly, it seemed to me that the people that testified—I'm not sure I remember who it was—said that we were pretty, they were pretty sure that the oxides of nitrogen, the sulphur, were definitely involved in causing some of the deterioration that they noticed. They couldn't put hard numbers on that, but the way I took it was that they were pretty sure that if we did anything to decrease either of those agents that we would be moving in the right direction. That was about the way I took it.

Is that a fair statement or do you recall what was said a year ago?

Mr. **Philpot**. I think it might be a fair statement based upon some of the statements that were made at last year's hearing, but I'm not sure I would agree with the statement.

Mr. **Ehreth**. I would agree with Dr. Philpot on that, too.

Mr. **Olin**. Excuse me, Mr. Ehreth?

Mr. **Ehreth**. I would agree with what Dr. Philpot just said on that. I don't think—I happened to be one of the witnesses last year from the Government panel—I don't think that any one of us said that, but I do believe that some of the witnesses said that. I don't think that we'd be in any position to agree with that even today.

Mr. **Olin**. I remember first asking questions about this area about 5 years ago, and the story then was that, well, the Government is undertaking a 10-year program to really get the answer. You talked about your program having been 1 year in existence. Am I mistaken that somebody else has been working at this 4 years longer than that within the Government or——

Mr. **Ehreth**. I'm saying that the NAPAP put its emphasis, put the emphasis it currently has on forests about 1½ years ago. That's what I said before. That's what I meant to say, I should say.

Mr. **Olin**. How about other aspects of acid rain? Has that been worked on longer?

Mr. **Ehreth**. Yes, in the aquatics area it's been worked on since the inception of the program. Quite frankly, therein lies some of the reasons for why we are where we are in part of the program as opposed to the forest program. We've had an aquatics history—a history of scientific studies in the aquatics area for some time, predating even NAPAP, that built up sort of a storehouse of knowledge, if you will, a reservoir of knowledge. We've only begun to look at these phenomena with regard to forests over the last couple years, with the exception of those isolated studies in the sixties or seventies that both of us mentioned earlier.

Mr. **Olin**. I guess I would then tend to agree with Mr. Panetta that if this legislation tends to pull this all together, we're going in the right direction because there's obviously a relationship between the aquatic aspects and the vegetation that we're talking about. If, in fact, the current levels of pollutants in the air are causing some bad effects, the sooner we set about getting some reduction in those, the better off we're going to be.

Granted, we don't want to shut down the country in the process of doing it, but if you just let it ride forever, it may do an awful lot of damage before you start correcting it.

What kind of urgency do you gentlemen see in this subject, maybe Mr. Leonard from your standpoint?

Mr. **Leonard**. Let me ask Dr. Philpot to respond to that question.

Mr. **Olin**. Mr. Philpot.

Mr. **Philpot**. Urgency in what sense, sir?

Mr. **Olin**. Urgency of coming to some conclusion and at least starting some degree of reduction of the pollutants that you know are certainly part of the cause. Maybe you wouldn't agree even with the question, but try answering it. [Laughter.]

Mr. **Philpot**. I guess I'd just say that we're all concerned about the health of the forests. I'm not sure that you could get much support right now that it's an urgent problem in the sense of the acidic deposition question. I think there's a growing consensus in this country that there's a fairly urgent problem related to the ozone and photo-oxidant question, again depending on what we mean by the word "urgent."

But I have to agree with our EPA partners that one of the things that we worry about more than anything else in terms of urgency is that we would have legislation mandating a major reduction in sulphur dioxide, and that the reason we would do that is because we're going to save forests when the research program in just a few years may come out and make it very clear that that's not what's affecting forests; what really affects forests is photo-oxidants, which primarily come from oxides of nitrogen, which come from an entirely different source, at least in a major sense, than sulphur dioxide. So there's a very, very serious national policy issue related to how that research comes out as it relates only to forests. If you want to talk about aquatic systems and other things that acid rain may affect, you may come to a different conclusion.

Mr. **Olin**. How many years do you estimate it will be before you have a definitive statement to make?

Mr. **Philpot**. Within the next 2-year period, we hope to get some definitive answers on the sulphur and nitrogen questions as they relate to U.S. forests. We're optimistic that we can do that by 1990.

Mr. **Olin**. By 1990, you'll be able to say, "Yes, it looks as those these are the things that need to be improved."

Mr. **Philpot**. Yes, that's our objective.

Mr. **Olin**. Or these aren't the things.

Mr. **Philpot**. Or they aren't the things; right.

Mr. **Olin**. That would be real progress. Thank you.

Mr. **Volkmer**. The gentleman from Indiana.

Mr. **Jontz**. Thank you, Mr. Chairman.

Mr. Leonard, on page 5 of your testimony you outline some research programs that are now ongoing. Can you elaborate a little bit about the eastern hardwoods research program?

Mr. **Leonard**. Let me ask Dr. Philpot, who heads that program, to respond.

Mr. **Philpot**. The eastern hardwoods program is one of the cooperatives under the forest response program. It is supported and managed by a combination of EPA and Forest Service personnel and resources. The program was initiated this fiscal year. It's primarily looking at a definition of the problem. One of the real issues we have in the hardwoods is that we have very, very scanty evidence that there's even a problem to address. This program is taking the approach of surveys and correlated studies.

For example, they've designed an experimental study to look at a sampling of sugar maple stands across the eastern United States and in Canada—it's a Canadian-United States effort—to see if we can measure enough things on enough sites against a pollution gradient to at least say or not say that there's a potential relationship between sugar maple declines and deposition gradiants. The study should at least give us enough evidence to determine whether there is a problem and how to proceed.

The program is also doing chamber studies. Seedlings from nine hardwood species and white pine, which we're using as an indicator species, are being raised and put through growth chambers and treatment chambers in a couple locations in a 2-year test. The objective to find out if treatments with acidic deposition and ozone, or in combination, will affect seedlings of those species. That, again, is more of an assessment approach than it is a research approach.

Within another year, or about 18 months, we should be able to give EPA and Forest Service managers, a good, definitive analysis on whether we ought to continue research on eastern hardwoods or whether we ought to terminate it and say there's no problem.

Mr. **Jontz**. And this is one of four cooperative research programs?

Mr. **Philpot**. That's right.

Mr. **Jontz**. Can you describe for me briefly what the administration has requested in its budget, Mr. Leonard, for this particular program? Is that a definable quantity?

Mr. **Leonard**. There is a total of $20 million in the EPA and Forest Service budgets for this type of research.

Mr. **Jontz**. That's the request for the coming year?

Mr. **Leonard**. For fiscal year 1988.

Mr. **Jontz**. How does that compare to the existing level of funding?

Mr. **Philpot**. We could only answer the Forest Service request part of that question. There is a small reduction in the present budget related to slowing down and holding up a little bit on the National Vegetation Survey. We would be glad to provide the exact numbers for the subcommittee, if you would like us to do that. We can get that and send it back up to you.

Mr. **Riordan**. We'd be happy to do the same, sir.

[Material supplied follows:]

FOREST RESPONSE PROGRAM

[In millions of dollars]

	Fiscal year	
	1987	1988 (President's)
U.S. Forest Service	8.250	7.925
Environmental Protection Agency	10.230	——

[In millions of dollars]

	Fiscal year	
	1987 current estimate	1988 President's budget
EPA contribution to Forest Response Program (R&D only)	11.1	11.1

1. S&E costs are currently estimated at $0.7 million for FY87, and the President's budget for FY88 shows $0.7 million. S&E is not included in the matrix above.

2. The latest FY88 estimates show an increase of $0.4 million for R&D, and no substantive change in S&E. But since the FS reported the President's budget, we probably should too.

Mr. **Riordan**. My recollection is just about no more than 2 or 3 years ago I don't think the total program was more than about $2 or $3 million. It's grown substantially in 2 or 3 years; isn't that right, Dr. Philpot?

Mr. **Philpot**. Yes, it's grown, a large growth in the program in the past 2 years.

Our basic philosophy or our direction within the Department of Agriculture was to protect the forest response program in the President's budget, and that's what we've done with that one exception I talked about for the National Vegetation Survey. We're just trying to make the point that we are not ready to do that survey and we can get by for another year or two with reduced funding. We'll come back to Congress if we need additional funds at that time. But the research program has been protected.

Mr. **Jontz**. Are there funds that are currently appropriated that go to the States for research purposes?

Mr. **Philpot**. I'm not aware of any projects being done by States, but I will say this: the research money that we're talking about, the EPA and Forest Service funds we're talking about, are awarded on a competitive basis to anybody that wants to compete for them. In other words, this is not an in-house program for USDA scientists or EPA scientists.

If a State came to us with a good proposal for a piece of the work that we want done, it would go to the State. But I'm not aware of any State right now doing research. We have cooperative relationships with several States. One, for example, is the California Air Resources Board which has a large program in California with both Forest Service projects in California and the Western Conifers Cooperative, which is managed by EPA out of Corvalis. We've got a lot of ties with the State of California, as one example.

Mr. **Jontz**. Thank you very much.

Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you.

I want to thank the panel.

Before we go to the next panel, I would like to say that in my opinion—and I'm only one member of the full committee—I do believe that this legislation as it moved last year will move through the House at least, at least through this committee, and perhaps through this subcommittee, within not too long a period of time.

I would appreciate it if you would review it and, if you have any areas which you feel could be corrected or changed, that need to be in order to fulfill the program as we would envision its operating, we wish to work with you, not against you. We would appreciate it if you would do that if you do find any parts that are objectionable or parts that you feel are not included which should be included.

As I review it, I see no reason why, if this would become law, where it would impinge adversely on you, nor do I find in here—maybe you can correct me or somebody over in your office can correct me—where you would be foreclosed from working with EPA or any other Federal agency on this. It would just mean that you're the one that's going to be responsible for this program.

I would appreciate that, if you would.

Mr. **Leonard**. Thank you, Mr. Chairman. We'll certainly try to respond to that.

Mr. **Volkmer**. I would appreciate that.

With that, that will conclude this panel. Our next panel will be Dr. Robert I. Bruck, Department of Plant Pathology, North Carolina State University, Raleigh, North Carolina, and Dr. Benjamin Stout, program manager, national air quality and forest health, National Council of the Paper Industry for Air and Stream Improvement, Inc., New York, New York.

Gentlemen, your statements will be made a part of the record. You may either review those statements in full or summarize, however you so desire.

We will begin with Dr. Bruck.

STATEMENT OF ROBERT IAN BRUCK, ASSOCIATE PROFESSOR, PLANT PATHOLOGY AND FORESTRY, NORTH CAROLINA STATE UNIVERSITY

Mr. **Bruck**. Mr. Chairman and members of the subcommittee, I appreciate the opportunity to appear before you today to testify before this subcommittee in support of continuation of funding for forest decline research.

I have included three papers in my written testimony. Now, however, I would just like to talk from my executive summary.

My name is Dr. Robert I. Bruck. I'm associate professor of plant pathology and forestry at North Carolina State University in Raleigh. I bring to you today 8 years of experience in conducting research on effects of atmospheric deposition on forest ecosystems. My research into the potential cause and effects of air pollution damage to high-elevation spruce fir forests has received a number of Federal grants including my interactions as coprincipal investigator of the EPA Mountain Cloud Chemistry Program at Mt. Mitchell. I also come to you with the perspective of a practicing scientist dealing with this problem.

The continuation of a long-term Federal research program to address the issue of forest health in the United States is essential, and I emphasize that. It must be emphasized that the contemporary issue of forest decline is an extremely complicated one. The mortality of trees observed across large areas of Central and Eastern Europe over the past 6 years has been unprecedented and in certain cases alarming.

Despite the large amount of research initiated over the past few years to discover the causes of forest decline, at this time there is no scientific consensus as to the primary or secondary triggering agents dealing with this syndrome.

The forests of Eastern and Central Europe appear to be threatened by a mysterious combination of natural factors including climate, pests, pathogens, in addition to a virtual vegetable soup of anthropogenic airborne pollutants that seem to be implicated either as primary or secondary stress factors at this time.

Recent evidence included in my written testimony suggests that similar processes have been and continue to undermine the health of North American coniferous forests, in particular those of high altitude. Although much is not known, the stakes are high. The extent of destruction is of great concern. Today nearly 6 million hectares of forest have been disturbed in the affected forests of five

Central and Western European countries. Other damages have been noted in the Netherlands and in Eastern United States.

The first signs of this unique disease phenomenon appeared to show up in the early 1970's in West German white fir, *Abies alba*. However, in West Germany in the late 1970's the decline syndrome spread to Norway spruce, the principal commercial species.

By 1980, it was apparent that a new type of forest decline symptom was being observed which was unprecedented in the phytopathological literature. Recent research has revealed that coniferous forests in both North America and Europe have been under continuous stress for at least the past three decades, as indicated by increment core declines in growth. Increment cores taken from thousands of southern Appalachian United States conifers over the past few years have shown that annual growth rates—i.e., the increment of annual growth—has slowed down at a period that began in approximately 1958 to 1963 and appears to be continuing at the present time.

Other than the balsam wooly adelgid on fir in the southeastern United States, no significant pests or pathogens have been determined after 3 years of intensive research. In some illustrated severe cases such as Mount Rogers in Virginia and Mount Mitchell in North Carolina the growth rates of red spruce and Fraser fir have been severely stunted, in some cases decreasing an average of 82 percent, a fivefold decrease since the early 1960's.

Although there is no concrete scientific evidence as to the cause and effect etiologies of forest decline, there appear to be a number of hypotheses that in fact are being explored at this time. This includes:

Forest decline must be understood as a disease syndrome of multiple factors, and my colleagues from the EPA and the Forest Service were using this terminology earlier today—a multiple etiology type of predisposal and finally the destruction of a forest ecosystem.

The primary cause of many of the most severe declines at this time does not appear to be pests and pathogens, although these may and probably do act as secondary factors on predisposed ecosystems.

Climatic factors such as drought and frost must be considered as being actors in the problems that we see, but, again, in many of the areas that I have studied they appear to be secondary in nature and, in fact, are most significant on stressed ecosystems.

Atmospheric deposition, then, of air pollutants or pollutant-related toxic, nutrient, and growth-altering substances are among the primary suspects of forest decline syndromes, particularly at high altitude.

One of the great frustrations of forest scientists involves the fact that different forms of air pollution are deposited at varying rates in different ecosystems. Little is known at this time, particularly on regional scales, about what types and forms of air pollutants exist. Some of the current hypetheses involve, as previously stated:

Ozone damage directly damaging trees.

Ozone damage combined with acid rain causing the leaching of nutrients from the foliage of trees.

The foliar fertilization increase due to air-borne nitrogen has been hypothesized, and much research is going on at the present time.

Growth-altering substances such as volatile organic carbon compounds are considered to be a possible actor, particularly when hormone anomalies in tree growth are suspected.

Direct nutrient leaching of the foliage by acid deposition has been postulated and is a very popular theory, particularly in West Germany.

Nutrient leaching from the soil due to acid deposition is another hypothesis being studied.

Aluminum mobility may be the result of this acidification of soil systems directly damaging root systems along with mobilizing other heavy metals.

Any and/or all or none of the above-mentioned hypotheses may, in fact, be involved in the deterioration of forest ecosystems, as previously stated.

A disease syndrome as complex and widespread as forest decline requires a comprehensive and long-term response. It is the opinion of this witness that the burden of research programs must be borne by the Federal Government of the United States. There is little doubt that sulphur and nitrogen oxide emissions throughout the Eastern United States are large, but they may only be part of the forest decline problem or perhaps not a part of the problem at all.

Most studies, both in Europe and North America, on the detrimental effects of air pollutants on forests have been made near and around large emission sources such as smelters where air pollution damage is acute. Far less is known about the effects of acid deposition and other air-borne chemicals on the broadly dispersed and different types of forests in the United States, and particularly the effects of long-distance transported chemicals and photochemically oxidized chemical products.

If, and only if, sufficient time and stability of funding sources are provided can significant progress be made over a period to be able to discern whether or not air pollution is the cause, primary or secondary, of forest decline syndromes. We need to learn in far greater detail about the responses of forest ecosystems to natural and anthropogenic stress before we can even dream about coming up with broad cause and effect answers. The scientific standards of rigorous proof in discerning cause and effect relationships are far down the road at this time. We must generate large and integrated data sets concerning natural processes and their effects on forest ecosystems.

In addition, we must be able to make better predictions of the influences of air-borne sulphur, nitrogen, and acidic substances on the nutrient cycling processes in our forests. These data must be integrated to descriptive and quantitative models to predict the influences of exposure to anthropogenic pollutants.

The current Federal research programs as they are devised probably will not be able to provide the answers that Congress and regulators will need by the 1991 termination of the NAPAP programs as they currently exist. I believe that by the termination of the NAPAP programs there will not be sufficient proof that one or several pollutants can cause decreases in productivity and damage to spruce fir ecosystems, ecosystems that are in fact most vulnerable in North America.

Although much controlled and experimental work will have been accomplished by that time, rigorous proof will not be available concerning the mechanisms of controlled exposure studies and how they are influencing whole forest ecosystems. Only through long term and highly coordinated and integrated research programs can we hope to find the answers to these questions.

Modern-day forest scientists are challenged with a very unique problem, the problem being to provide Congress, legislators, regulators, and policymakers with sound answers so that proper legislation may be adopted to protect our most important natural renewable resource; i.e., American forests.

The problem is further compounded by the fact that we must now study ecosystems that at least in the case of red spruce can grow and evolve over a period of 400 years. For decisionmakers to ask scientists to provide them with the answers to such a complex enigma within a period of 3 to 5 years is, in the opinion of this witness, not responsible.

There is no doubt that the cost of a long range and integrated program for research and development will be high. The solutions remain before this committee today and may ultimately depend on a narrowing of the dichotomy between rhetoric and reality in persuading the decisionmakers to mandate sound research and environmental management programs.

The cost of research is high, but it probably represents only a fraction of the cost of controlling air pollution on a wide scale. The cost, therefore, of making foolish and uninformed decisions could be far greater and perhaps the cost of not doing so could be astronomical in terms of the ecological and economic damage to American forest resources. A far greater and integrated research program needs to be mandated post haste. It is my hope that this subcommittee begins to take action to initiate such long-term programs today.

I thank you, Mr. Chairman.

[The prepared statement of Mr. Bruck appears at the conclusion of the hearing.]

Mr. VOLKMER. Thank you very much, Dr. Bruck.

Dr. Stout.

STATEMENT OF BENJAMIN B. STOUT, NATIONAL PROGRAM MANAGER, AIR QUALITY AND FOREST HEALTH, NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC.

Mr. STOUT. Mr. Chairman, members of the subcommittee, I'm Benjamin Stout, the national program manager for air quality and forest health for the National Council of the Paper Industry for Air and Stream Improvement. With a long name like that, you can imagine we would shorten it to NCASI. This organization is the research arm of the forest products industry.

Before addressing future research needs, it might be useful to review briefly the state of the existing research program on air quality and forest health. Since the National Acid Precipitation Assessment Program, NAPAP, was authorized in 1980 we have seen the Forest Service and the Environmental Protection Agency develop research programs that are coordinated with the forest industry through NCASI and the electric power industry through the Electric Power Research Institute effort. The coordination, missing early on, has produced a positive synergism among the program participants.

Today a substantial research program is in place, supported with public and private funds, to examine questions related to air pollution to forest health and productivity. During 1987, it is expected that the forest response program, administered jointly by the EPA and the Forest Service, along with the programs of EPRI and NCASI, will expend over $20 million in research related to air quality and forest health.

We have learned some things since we started. For example, we originally focused our research solely on the effects of acid rain. It now appears that sulphur and nitrogen compounds may not be having all that much effect on our forests and that ozone, and perhaps other oxidants, deserve more attention, but there is still much that must be known before any conclusions can be reached. I expect you've gotten tired hearing that one. To get these answers, we must broaden the scope of our research.

Mr. Chairman, I hope this does not give the impression that we are dissatisfied with the current NAPAP structure or program. NAPAP was a response to an immediate need and was based on the best knowledge available at that time. Its program management structure has proven very effective in coordinating the research efforts of the EPA, the Forest Service, and the private sector. Although we consider the limited scope of the research restrictive, we have, through proper coordination, been able to move toward many of our initial research objectives.

However, there are some future concerns. Specifically, there are those who would argue that the focus of NAPAP should be narrowed to just acidic deposition and that other programs should work on pollutants such as oxidants. The NAPAP authorization is scheduled to expire in 1990, and potentially with it much of the hard-won research coordination currently in place.

Finally, the forces of agency autonomy are acting to produce essentially distinct efforts in forest effects research with regard to air pollutants. I refer specifically to an ozone program being developed in EPA that is outside of the existing NAPAP effort.

Mr. Chairman, as the committee considers H.R. 2399, we urge that the following be kept in mind:

Many of the actions specified in the bill already are being addressed by the Forest Service. For example, forest inventory work is underway to determine methods for quantifying trends in forest health and productivity. Also, a national research plan for the forest response program has been developed within the NAPAP structure that lays out long-term research needs and the current NAPAP forest response program structure effectively fosters the needed cooperation among Federal, State, and private researchers.

After NAPAP's scheduled termination in 1990, there will be a continuing need to foster coordination of Federal, State, and private research efforts. The existing focus of forest health research on acid rain should be expanded to include ozone, heavy metals, and other air pollutants.

Finally, there is need to have stable, long-term funding for our research efforts. Research, particularly related to forest health and air quality, requires a long-term commitment. It is not something that can be turned on and off like a light switch and remain effective.

Mr. Chairman, let me emphasize that my purpose today is to speak to the long-term research needs and to urge that money appropriated for research is used in the most prudent way possible. Recent experience has shown that Federal agencies with very different missions can cooperate to conduct an integrated forest effects research program. From the standpoint of an industry that is dependent on productive forests and one that contributes to the research effort, we hope that this will continue.

I appreciate the opportunity to offer these comments and will be happy to answer any questions. Thank you.

[The prepared statement of Mr. Stout appears at the conclusion of the hearing.]

Mr. **Volkmer**. Thank you very much.

It appears—and correct me if I'm wrong—Dr. Bruck, there is no question from your testimony, in my mind at least, that you feel that we need to go beyond 1990 with research and that that research needs to be expanded beyond where we're now covering in NAPAP; is that correct?

Mr. **Bruck**. That is correct. My feeling is that we're in a situation right now where the programs are in place, and I'd like to concur with Dr. Stout that the programs are quite effective and we have a good start on being able to get to the answers that we need. However, again concurring with Dr. Stout, the idea of turning things on and off like a faucet, particularly when it pertains to forest ecosystems, is a very dangerous thing. What we don't understand about forests could fit a few books. The long-term nature of these programs to get responsible answers I think is essential.

Mr. **Volkmer**. Well, that gets me to Dr. Stout. When I review in your statement your future concerns and then I look to see what's in the bill, I think aren't those future concerns basically covered with what's in the bill?

Mr. **Stout**. That would be my reading.

Mr. **Volkmer**. And as far as diluting the research funds, I don't think any of us plan to do that. We just want to try—what we're trying to do with this legislation is trying to focus the research broader, as Dr. Bruck has said, from a broader aspect than where we have it now, and then to try to set up just a few guidelines and then say, "Now go to it, and you've got 10 years to do it in." It's not 2 or 2½ years. We don't expect that much to be done in that period of time. I don't think anybody can, do you, either one of you? Do you think we can have this all wiped up by the end? When NAPAP goes out in 1990 we've got it all wound up and we know all the answers?

Mr. **Bruck**. I don't believe we'll have anywhere near all the answers at that time.

Mr. **Volkmer**. Do you agree with that, Dr. Stout?

Mr. **Stout**. Yes.

Mr. VOLKMER. I have no further questions. Does anybody else?

The gentleman from California.

Mr. PANETTA. Thank you, Mr. Chairman.

Dr. Bruck, in your testimony, you gave a summary of causes which include four areas: (1) this is a disease syndrome; (2) the primary causes are not due to insect or known forest pathogens, although I guess they play a secondary role; (3) climatic factors such as drought and frost and, I guess the assumption is it's probably secondary; and (4) the atmospheric deposition of air pollutant or pollutant-related toxic nutrients.

It seems pretty clear that the direction of most research indicates that one of the primary causes seems to lie in atmospheric problems related to pollutants. Is that a fair assumption?

Mr. BRUCK. I believe that the answer to that question is via a process of deduction. As a forest scientist and particularly as a pathologist, it is my charge to search for anything and everything that I can attribute a problem in a forest to. We look at the biotic factors which we review. We look at trends in terms of climate: has climate changed? Has it been very cold, warm, wet, dry, these kinds of questions?

When we come up with very little cause and effect evidence from those types of investigations, we naturally look for other things. When we began our initial studies and found that there seemed to be a high degree of correlation, particularly in the high altitude forests, to the deposition of all these, as I said, vegetable soup of compounds and elements out there, we began saying, "Is it possible that these things could have a cause and effect relationship?"

As research goes on—and we are now only in the second year of the Mount Cloud chemistry program—some of the things that we have found, which are included again in my written testimony, we were flabbergasted with. We really did not believe that clouds could be as acid as they were. We did not understand that ozone concentrations could be as high as they were at the tops of these mountains and these forests. Now we have to go through the process of doing responsible science and seeing whether the correlation of the existence of these pollutants and the concomitance of decline are in fact either coincidental or in fact causative in its nature. That takes time.

The problem, as was stated by the gentleman from the EPA earlier, is that there are virtually hundreds, if not thousands, of catalogued air pollutants in our air. Which one or combination of these things are you going to regulate? If you regulate sulphur and in fact sulphur is not the problem, and forests are the excuse for doing that regulation, 5 years from now you may be wanting in terms of coming up with an excuse as to why we spent billions of dollars to save the forest; yet the forests are still dying.

Mr. PANETTA. I fully appreciate that and obviously don't want to take that step without adequate research, but it appears from your testimony, and I respect your scientific background, that it seems the other areas you're looking at have pretty much been deduced as secondary factors, but whatever is causing the atmospheric deposition may be the major problem here. Is that a fair statement?

Mr. BRUCK. I think the answer to your question again—and I don't want to be evasive, but I think the fact is that each separate ecosystem that you could bring up probably has a different set of factors that you would have to attribute and sort of weave in and out of what is primary and secondary.

Last year in the Southeastern United States we had literally a 100-year drought. If you don't think that that's going to affect southern pine forests and everything, that's just not the way it works. It's going to have an effect.

Now the question that remains here is: is the forest predisposed or stressed from atmospheric deposition, so that it is going to show a greater response due to a natural phenomenon such as drought or frost than it would otherwise show? Those are very delicate questions and have to be very carefully answered.

I think the high-altitude forest, which is where I have my experience, is a very unique situation. Both in California and the West in terms of the San Bernardinos and what aggregates in terms of inversion layers at the tops of these mountains, and in the case of clouds that are in fact, in the words that have come from Albany State University, are vacuum cleaners. They're sucking up everything in the environment; they are depositing them uniquely in high-altitude ecosystems and, hence, we can measure empirically the presence of these toxicants.

In certain cases there is a definite situation where the risks are higher; in others it is a much more complicated situation.

Mr. PANETTA. I take it the area you have looked at, then, in the higher-altitude areas, there is no question that there's a relationship?

Mr. BRUCK. I can't say that to your question, sir, but I can say that I firmly believe after 4 years of personal research in spruce fir ecosystems that there is a connection between atmospheric deposition and the declines that we're seeing; yes.

Mr. PANETTA. Dr. Stout, in your testimony, I think at one point you concur with one of my concerns, which is the problem of different agencies that are studying the various factors working to protect their jurisdictions. You refer to the ozone program that's being developed in EPA that's outside of the NAPAP effort. You see a problem, I take it, in terms of the relationship between these agencies in doing the studies?

Mr. STOUT. It may be a problem. It seems to me that a better way to say it is that since we have gone through the miseries of getting the NAPAP organization operating and the cooperation developed, that we ought to maintain that because it is effective and we have two groups of people talking together. I see a tendency to dichotomize, and I think that's not in the best interest of wise use of research resources.

Mr. PANETTA. Thank you.

Thank you, Mr. Chairman.

Mr. VOLKMER. The Chair recognizes the gentleman from Alabama.

Mr. HARRIS. Dr. Bruck, did I understand, then, that you support the general initiatives and drives behind H.R. 2399?

Mr. BRUCK. Yes, I do.

Mr. HARRIS. What about you, Dr. Stout?

Mr. STOUT. Sir, I work for a research organization that if we do one thing, we steadfastly refuse to answer questions like that. We have in the forest products industry a whole group of policy people who will be glad to give you the forest products industry's position on the bill.

Mr. VOLKMER. Will the gentleman yield?

Mr. HARRIS. That sounds like a political answer, doesn't it? [Laughter.]

Mr. VOLKMER. Will the gentleman yield?

I believe, in all fairness to Dr. Stout, he has said that the legislation would take care of some of the problems he has elicited in his testimony. I think that is about as far as they can go. I don't think they normally endorse the legislation.

Mr. STOUT. We do not; that's right.

Mr. VOLKMER. Or oppose, either way.

Mr. STOUT. That's right.

Mr. HARRIS. They may just endorse or oppose people that do. [Laughter.]

Thank you. I appreciate the testimony. It's been very beneficial.

Thank you, Mr. Chairman.

Mr. VOLKMER. The gentleman from Indiana.

Mr. JONTZ. Thank you, Mr. Chairman.

Dr. Bruck, would you say that there is a substantial difference between research which establishes proof of cause and effect and research which establishes a relationship?

Mr. BRUCK. Well, there certainly is. This, of course, is one of the great philosophical debates that exists within this issue right now among scientists. If you take a look at the EPA as a regulatory agency, they do not need proof in the true scientific sense to regulate something. There are many instances of that. The contemporary issue, of course, with health and smoking and everything—no one has ever proved that smoking is bad for you, but epidemiologically you can make that type of a relationship or correlation.

I'm an epidemiologist. It is my particular field of endeavor. Hence, I am very biased toward statistics. When I actually do a piece of research that may last a period of years, and I have a correlation that is extremely high and it makes biological sense to me, that means a great deal to me personally.

There are other people in forest sciences, let's call it, who are perhaps physiologists, biochemists, people of this nature, who either it is or it "ain't", if you will. There's no statistical basis for making a decision. It is very empirical, point blank type of research.

This is a question that really I have a hard time dealing with because I provide the best types of data and do the best research that I can, and in many cases have demonstrated and published the relationships that exist between pollution and the phenomena that do exist in the systems that I am studying.

I am very careful and very pointed about saying that I do not have cause and effect proof. This is a branch of science that I personally do not delve into. However, many people are working on that.

It is difficult, particularly in very complex situations, environmental situations dealing with multiple etiologies, to ever develop cause and effect. There have been those who have suggested that no one will ever prove—and I underline "prove"—that air pollution cause forest damage in a chronic sense.

Mr. **Jontz**. That, to a large extent, is because you don't have the laboratory setting in which you can control certain variables to measure another.

Mr. **Bruck**. My answer to that is, if you don't like the weather on Mount Mitchell, wait 5 minutes. That's the answer to that. I mean, everything is constantly changing; that's correct.

Mr. **Jontz**. So whereas we might be on the most firm possible grounds by seeking to establish a cause and effect relationship, on the other hand from a pragmatic standpoint we may have to settle for less than that. I guess I want to pursue this just one step further.

Do you think, if you can put yourselves in the shoes of the public policy process or decisionmaker for just a minute—really what we're looking at is assessing when the probably cost of doing nothing outweighs the probable cost of doing alternative A or alternative B or alternative C. Is that a fair assessment of really the question that we are addressing in this research in terms of some pragmatic response?

Mr. **Bruck**. Well, there are two answers to that. As a scientist, theoretically I am disinterested in whether or not I'm answering questions that are going to lead toward regulation. My job is to discern facts.

Being a little bit more pragmatic perhaps than a scientist, the answer is that the regulatory agencies and certainly your body have to take into consideration these types of questions, as to how much is enough, whether or not the quality of our environment is worth preserving, because in many cases—and I would like to just point out from my testimony—if, in fact—and I emphasize "if"—air pollution was affecting these high-altitude ecosystems, causing growth declines, 30 years before visible damage occurred, that's partially answering your question that in fact you will not actually be able to measure and see perhaps damage in a true sense until after the damage has, in fact, occurred or after the predisposition period has gone away and you are into a period of decline.

It is a problem, and I don't have an answer to that in terms of how to do it. I think that data drives models. Models are the vehicle by which you are going to get your answers. By integrating all these data sets together, utilizing the state of the knowledge, and filling in gaps—I was at a meeting yesterday where we were discussing this exact problem—filling in the gaps in data sets, then literally you take your best shot in terms of deciding whether or not there is a problem, how long you can wait to ameliorate that problem, and whether or not the economics versus the environmental impacts are worth pursuing.

Mr. **Jontz**. Thank you. I believe that completes my questions.

Mr. **Volkmer**. I recognize the gentleman from Michigan.

Mr. **Schuette**. Thank you, Mr. Chairman.

Dr. Stout, I appreciated your testimony. You're also quite nimble on your feet. If you ever leave the practice of science, you could probably enter politics. You were quite agile, sir, in the answer to the gentleman's question.

Dr. Bruck, on page 6 you state the cost of study will be quite high. Do you have any estimate in your opinion as to how you would describe that other than "quite high"?

Mr. **Bruck**. I'm not a budget maker, administrator, et cetera. I'm just a lowly scientist. But the answer to your question is when I take a look at the expenses of my own program and what it costs to maintain field crews, to be able to buy the kinds of instruments and do the sophisticated types of statistical work that we have to do, this is inherently expensive research. I think that people from the EPA would probably concur that environmental research, due to the complex nature of it, is always very time consuming, very labor intensive, and, hence, it is expensive.

My statement is more as a perspective of a forest scientist. I think I would probably be correct in saying that the amount of dollars already that have been appropriated to deal with this problem in the United States is probably unprecedented in the history of forestry research. Never have we mobilized so much money and so many scientists to try to answer a problem.

My word of costly is a relative statement, relative to previous and prior experiences that I have had in dealing with forest problems.

In terms of the relevance to national budgets, we're not talking about a great amount of money, but of course every nickel counts in terms of whether or not it's being appropriated properly.

Mr. **Schuette**. Let me ask you one other question. You stated you support the intent and purposes of H.R. 2399, nor would I ask you to read another group or individual's mind, but could you share what your beliefs are of the perspective of the Forest Service and others who oppose this bill? Do you have an opinion on why some groups, as the Forest Service has testified, are opposed to this measure that I and other members of this subcommittee and the full committee have sponsored?

Mr. **Bruck**. Well, at the end of the testimony by the representatives of the Forest Service and the EPA both, I think that they probably stated that they do not oppose the bill for the sake of the bill. I think that their contention is that programs are already in place—and, indeed, they are; I am a part of the forest response program.

Mr. **Schuette**. Do you think it's just the overlap, then, or the fear of duplication?

Mr. **Bruck**. Again, I have hard time knowing exactly what the motivation is. I don't know if it's the fear of duplication. Perhaps there are other ideas of how to continue this program in their minds. Perhaps they are working on other vehicles by means of doing that.

I think my only contention and the reason why I am supporting this bill is that I believe that the earlier we get started in laying out the groundwork for a comprehensive, long-term program, knowing how long things take—this is a fact—the better off we are. I found nothing objectionable in the bill in terms of the way it was outlined and the jurisdiction that is already, as stated by the EPA and Forest Service, that's been delegated to these agencies.

Mr. **Schuette**. As a scientist, how do you deal with potential questions of overlap or duplication? How do you reconcile that?

Mr. **Bruck**. Well, overlap and duplication are a function of management, sir. If you have strong managers who are able to take the funds that are available and able to wield the powers that be into integrating a good program, and whether this comes from the NAPAP office, whether it comes from EPA or Forest Service, I don't know; again, I'm not that attuned to the politics of what's going on here. But a good leader can take a program and meld it into a cohesive, comprehensive program and a long-term program to enable people to have the security of staying out in the field, being in a laboratory, doing science, rather than worrying on a monthly basis as to whether or not there's going to be funding three months from now to be able to conduct their research.

Mr. **Schuette**. I thank you for your articulate testimony.

Mr. Chairman, that completes my questions.

Mr. **Volkmer**. Does the gentleman from Louisiana have any questions?

[No response.]

Mr. **Volkmer**. I want to thank both of you. This panel has been very helpful in the information provided us today. I appreciate your testimony. With that, we'll conclude this panel.

We'll have our third panel next: Mr. Don Hinrichsen, editor-in-chief of World Resources Report, World Resources Institute, Washington, DC, and Mr. Neil Sampson, executive vice president of American Forestry Association, Washington, DC.

Gentlemen, your statements will be made a part of the record and you may either review it in full or summarize it. We'll start with Mr. Hinrichsen.

STATEMENT OF DON HINRICHSEN, EDITOR-IN-CHIEF, WORLD RESOURCES REPORT, WORLD RESOURCES INSTITUTE, WASHINGTON, DC, AND INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT, LONDON, ENGLAND

Mr. **Hinrichsen**. Thank you, Mr. Chairman, members of the subcommittee. I want to thank the subcommittee again for inviting me to testify today on the subject of air pollution and forest decline.

Since my last appearance before this same subcommittee in May of 1986, the forest declines observed across large areas of Europe and North America have accelerated, both in terms of the areal extent of damage and the severity of that damage. It is now estimated that at least 8 million hectares of forests have been stricken by Waldsterben, the German term for forest death, in at least 15 European countries. The World Commission on Environment and Development recently put the damage at about 15 percent of the total forested area of Western Europe.

West Germany is still the hardest hit with some 54 percent of its forests, amounting to about 3.8 million hectares, affected by Waldsterben.

The forest decline syndrome is also increasing in extent and severity in Switzerland, Austria, Czechoslovakia, Poland, East Germany, France, Italy, Yugoslavia, and Sweden.

During 1985–86, particularly, the Swiss forests were badly affected. Overall, at least 36 percent of the country's forests are currently damaged by forest decline, with the most severely-affected regions in the Alps, where trees are vital barriers against avalanches. Switzerland's Federal Office of Forestry reported that the disease syndrome has attacked or killed some 43 percent of the trees in the central Alpine region situated between the French and Italian borders to the south and west and the Austrian border to the east.

The forest declines observed in Poland, the German Democratic Republic, and Czechoslovakia are thought to be far more severe than official figures indicate. Unofficial estimates place the amount of damage at up to 1.5 million hectares for Poland, 2.5 million hectares for the German Democratic Republic, and more than 1 million hectares for Czechoslovakia.

North America's higher elevation eastern coniferous forests have also experienced a rapid and severe deterioration since 1983–84. The most severely affected areas are in the Appalachian Mountains from Georgia to New England, but particularly the southern Appalachians seem to be severely affected.

A six-State study of the southern Appalachian region recently revealed that eastern white pine is suffering from pollution-related declines in 23 percent of the stands surveyed. The area with the highest incidence of decline was identified in Kentucky, where 77 percent of all the white pine surveyed there showed signs of air pollution damage. Even more alarming is the finding that the trees with air pollution damage were growing on average 49 percent less volume than healthy trees. The main pollutant known to damage white pine is ozone, along with other photochemical oxidants.

An extensive research program is also underway on Mount Mitchell, North Carolina, to study the widespread decline of both Fraser fir and red spruce noted over the past 3 years. Dr. Bruck, who just testified, is in charge of that research program.

Although there is little or no consensus yet as to the primary triggers in this process, as has been pointed out by previous speakers today, there is still a growing body of research that has given rise to six distinct schools of thought on the role air pollution may play in forest declines. I'll just outline these briefly.

The first is the general stress hypothesis, in which a multitude of pollutants react synergistically or in an additive manner to induce the damage symptoms.

The second is soil acidification or aluminum toxicity, which postulates that the wet and dry deposition of acidified particles is the main cause.

The third is ozone and other photochemical oxidants, which are known to damage trees and other vegetation.

The fourth is magnesium deficiency, which holds that pollutants leach essential elements for growth out of the soil, therefore leaving the trees starved for nutrients.

The fifth is excess nitrogen or excess nutrient deposition, which postulates that overfertilization from air-borne fallout of nitrogen compounds—for example, from fertilizers—is inducing the trees to grow too fast, causing a breakdown in their metabolic processes.

Finally, the sixth one is the deposition of growth-altering organic chemicals such as aniline and ethylene which can produce the bizarre dieback symptoms seen throughout Europe and in some of the higher elevation sites in Eastern North America.

Now out of these six schools of thought have emerged 10 specifi damage mechanisms whereby air-borne chemicals may contribut to forest decline. I'm not going to list all these because Dr. Bruc discussed these in his testimony, and last year I went into these i great detail in my testimony then. I would just like to point ou that in my opinion it's likely a mix; this chemical cocktail that's i the atmosphere is probably one of the main reasons or main connection between air pollution and forest decline. I think it is a mi of all of these different chemical compounds that play importan roles, but they vary from region to region, which is why it is so difficult to pin them down.

Now with so many suspects to choose from, it's hard for policy makers to formulate effective policies, especially since much mor fundamental research and laboratory work needs to be done befor scientific investigators are able to come up with some answers instead of more questions.

What these means, however, is that no single pollutant contro strategy is likely to be effective in dealing with forest decline. I will take nothing less than a total integrated mix of strategies an technologies tailored for each region to improve the quality of ai in Europe and North America.

In this respect, I would like to conclude by saying that I thin such policies must be tied to an overall energy strategy that als reduces the consumption of fossil fuels, thereby tackling anothe emerging problem, global climate change. The key, in my opinion to this is in dealing effectively with energy policy.

Thank you very much.

[The prepared statement of Mr. Hinrichsen appears at the conclusion of the hearing.]

Mr. VOLKMER. Thank you, Mr. Hinrichsen.

Mr. Sampson.

STATEMENT OF R. NEIL SAMPSON, EXECUTIVE VICE PRESIDENT, AMERICAN FORESTRY ASSOCIATION

Mr. SAMPSON. Thank you, Mr. Chairman.

I'm Neil Sampson with the American Forestry Association. I would like to call your attention to a reprint from our magazine that is attached to the testimony in front of you today as an example of the attempts we have been making in the past year, year and a half, to try to help the public understand what's going on in America's forests and try to help give us better information to try to translate to the American people. Therefore, in the testimony we've brought before you today we strongly support the bill that you have in front of you, as we did, I believe, about a year ago.

Let me just cover a couple or three general points in the interest of time and then we'd be happy to answer questions. It seems to me that as you look at this whole issue there are a couple of principles that perhaps often get blurred. The first is that forests serve more than trees. It makes me very nervous to have scientists essentially say we can't tell for sure the cause and effect relationship between air pollution and tree growth, but there certainly is something happening to the aquatic system. Well, to the forest, the aquatic system is a pretty important part. If there is an impact on the aquatic system, it's pretty certain that there's some kind of an impact on the forest ecosystem as a whole.

I only bring that up to point out that in these very large, complex ecosystems we don't know for certain what the miner's canary really is, let alone what's happening to it or what that means. We need to think about this whole issue in a more holistic way, I think, than we often hear at times.

The second general principle that seems to me we need to keep in mind is that forests are extensive. A 1- or 2-percent impact on growth may not be detectable, but it could result in enormous volume impacts if it takes place over a number of years and, therefore, we need to be constantly wary of small, but extensive impact.

Finally, it seems to us to be almost axiomatic that the Nation is going to probably have to move on air pollution control legislation without the answers it needs on this question. It will almost certainly move without full information and it may move without some very important information.

The question does become, as one of your panelists said earlier, a balance between the cost of doing nothing and the cost of doing something. We think that the time is rapidly approaching where the weight of the evidence suggests that it's clearly time to begin to think about moving ahead. In the meantime, the extension of and broadening of the NAPAP effort as envisioned in H.R. 2399 is an essential move, we feel.

Let me make one point about H.R. 2399. Near the end in section 3(b), I believe it is, there are some reports called for that seem to suggest that the Forest Service might provide you with recommendations about moves to take in light of the findings of the research impact of air quality on forests. Let's let the record be clear about the fact that the Forest Service's recommendation should stick to forest management and forest research and forest reactions which could help mitigate and not get their scientific and technical credibility stretched off too far into emissions reductions, transmission, pollutants, and a lot of the other things that go on in this issue.

There are some tremendously important decisions that need to be made. They are social judgments as much as technical judgments, and I would only caution you to make sure that the Forest Service doesn't seem to be asked or get to be asked to go too far beyond their technical credibility.

With that, Mr. Chairman, we appreciate the chance to testify. We'd be happy to react to any questions.

[The prepared statement of Mr. Sampson appears at the conclusion of the hearing.]

Mr. VOLKMER. What you're saying, if I may paraphrase it in my own mind, is that the Forest Service shouldn't be determining the policy or making recommendations in regard to the policy of what to do; is that what you're saying?

Mr. SAMPSON. Yes. And if it gets down to the fact of do we or don't we do emissions reduction with a certain quality and by how many million tons, I think they clearly should be kept out of it. The record should show that wasn't what they were asked to comment upon at the outset.

Mr. VOLKMER. But they could provide the data as to what is ongoing in our atmosphere and what's being——

Mr. **Sampson**. Absolutely, and the impact——

Mr. **Volkmer**. The data that comes with that, et cetera, for some of us in the policy decision, whether in administration or here, to try to make the decision what to do about it?

Mr. **Sampson**. Absolutely. And in some instances, some of the mitigation may, in fact, with tree genetics, tree management, and other things. There are ways to handle things that they should be taking a look at at the same time.

Mr. **Volkmer**. Other than that, you have no objections to the legislation?

Mr. **Sampson**. We have no objections to the legislation.

Mr. **Volkmer**. Mr. Hinrichsen, do you have any feelings as to whether or not we should go ongoing with this? Basically, the legislation calls for the 10-year program. I believe it broadens it from where we are in NAPAP. There's no question in my mind that it does broaden it beyond just the question of acid and ozone and——

Mr. **Hinrichsen**. Yes, I think we're definitely going in the right direction. I would also like to emphasize something that Bob Bruck pointed out earlier in that I think you have to in the end evolve a long-term program as well because the research is so complicated.

Mr. **Volkmer**. All right.

Mr. **Hinrichsen**. You're certainly going in the right direction.

Mr. **Volkmer**. Thank you very much. I appreciate those comments.

Does the gentleman from Alabama have any questions?

Mr. **Harris**. No comments, no questions, Mr. Chairman.

Mr. **Volkmer**. The gentleman from Michigan.

Mr. **Schuette**. Thank you, Mr. Chairman.

Mr. Sampson, you stated that there is no doubt—I'm paraphrasing—that we will have to move forward without all the answers in the absence of hard scientific relationships as to what the true causal problems might be with respect to forest declines, death in the forests. I think I know the answer, but is the answer—why don't you say it?

Mr. **Sampson**. I don't know that I heard you formulate the question yet.

Mr. **Schuette**. Let me ask it better and more appropriately, then. You're saying that we need to move forward with implementing measures and controls to try to control and prevent the decline in forestry and the ecosystem without having all the hard scientific evidence as to what might be the specific cause of the decline, the decay, the death, so to speak. Is your feeling that we need to do this because the balance tips the scale toward acting even though we may not be acting in the correct way to cure the cause?

Mr. **Sampson**. It seems to me that the sum of the factors, the political and the economic factors, seem to be moving us in that direction; that there's enough evidence on impacts on aquatic systems; that there's enough evidence of at least a question and concerns on some of these pollutants. I am in firm agreement with the prior witnesses that we shouldn't swat at one mosquito and pretend we've solved the whole problem, but it seems to me almost certain that the political pressures are going to move Congress to act on the air quality bill before you have all the answers you need. If it didn't, I would say that would be the first time in history that the

Congress hasn't been moved on environmental legislation without all of the technical information it needs.

Mr. SCHUETTE. Politics aside, on a scientific and policy basis, do you think that's correct?

Mr. SAMPSON. Yes, it probably is. You know, the problem with this is that you see a little beginning of a hint of a problem and you go back and look and it's been 20 years manifesting itself, and the sine curve of where it's liable to take us is probably already established for the next 15 or 20 years. That suggests that in these kinds of issues you simply can't wait until you know everything and until the scenario has played out to begin to change that course and try to mitigate those damages.

It seems to me that's the nature of these issues. That's what makes them such very difficult public policy issues, both for policymakers and scientists.

Mr. SCHUETTE. Thank you very much, Mr. Chairman.

Mr. VOLKMER. The gentleman from Louisiana.

Mr. HOLLOWAY. I agree with the bill and the testimony that has been before us, but I feel that sometimes we study problems to death. We find out what the answer is, but yet we want to study the problem some more. If we find out what the problem is, let's do something about it and not continue to study it for the next 40 years. I have a similar situation with hazardous waste dumps in my district. EPA knows that they have to be cleaned up but yet they insist on studying them some more. Industry has paid billions of dollars to have it cleaned up, but the Federal Government hasn't moved the first shovel of hazardous waste yet. I say studies are great, but when we find out what our problems are, let's do something about them.

Thank you.

Mr. VOLKMER. Mr. Sampson, you have no fear that if the Congress in the name of cleaning up our whole ecosystem problems by passing "acid rain" legislation—that's a cure for all. I've heard here today that that's not going to be a cure for all.

Mr. SAMPSON. It won't be a cure for all. We know for sure it won't be a cure for all. I didn't say that at all.

Mr. VOLKMER. You didn't say that. You didn't say that, but that's—as I see how the Congress operates, we have now solved that problem; we're going on to the next problem.

Mr. SAMPSON. That's the real key important thing with this research. If, in fact, an apparent cure is used as rationale to stop the research question—this gets back to the point Mr. Holloway made—if some sort of a placebo cure is used as an excuse to stop the research on something as complex and long range as this one, we will lose a great deal.

Mr. VOLKMER. I think that's what I'm seeing coming down the pike. That's what bothers me considerably because we're only hitting part of a larger problem; is that right, Mr. Hinrichsen, as I understand your testimony?

Mr. HINRICHSEN. Yes. I think, as previous people have testified today, too, it's an extremely complex situation. It requires a long-term, comprehensive research program which may take some years to bear fruition. In the meantime, you're actually asking your policy people to make some decisions based on a very incomplete picture. I think that the research has to be accelerated. That's the first thing. Then you can at least make some rational decisions on the information that you can get in the time that you have to make a decision.

Mr. VOLKMER. It has been said earlier that we can take all of the SO2's and all of the nitric oxides out of the air, but we haven't solved a thing as far as ozone is concerned, have we?

Mr. HINRICHSEN. That's right. No, that's only part of the picture. You've not dealt with ozone; you've not dealt with heavy metals; you've not dealt with the nitrogen deposition problem; you've not dealt with organic chemicals. There is this chemical cocktail in the atmosphere that probably plays a role in forest declines but each of them will have more importance depending on where the site is and what region it's in.

Mr. VOLKMER. Correct.

Mr. HINRICHSEN. That's what I have tried to point out.

Mr. SAMPSON. Mr. Chairman, if I might add, I didn't hear it said here today, so I guess I'll say it: an example of the complexity of this, the ARS just recently released information from Beltsville and from California indicating that fog clouds, fog banks and clouds are picking up pesticides at rates which are many quantum times more than would have been predicted by the basic physics and scientific theorem of how atmospheric dispersion of chemicals exists. They're finding that clouds then contain essentially a toxic mix of agricultural pesticides picked up and swept off the land and then moved into an area. That hasn't yet been factored in. We don't know yet what that means. But what that has done is questioned the basic physical relationships that have been driving scientists for decades on this. We're learning things that are so basically new on this one that we're a long ways from knowing what's going on.

Mr. VOLKMER. Thank you very much. I have no further statement or question. I appreciate your testimony. It has been very helpful.

We will conclude this panel and we will adjourn the hearing.

[Whereupon, at 3:48 p.m., the subcommittee recessed to reconvene at the call of the Chair.]

[Material submitted for inclusion in the record follows:]

STATEMENT OF
GEORGE M. LEONARD, ASSOCIATE CHIEF
FOREST SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Before the
Subcommittee on Forests, Family Farms, and Energy
Committee on Agriculture
United States House of Representatives

Concerning

H.R. 2399 - Forest Ecosystems and Atmospheric Pollution
Research Act and the Status of Research Programs on the
Effects of Atmospheric Deposition on Forests

June 9, 1987

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

I am pleased to appear before you today to describe the status of the air pollution research being conducted by the Department of Agriculture, Forest Service. Accompanying me today is Dr. Charles W. Philpot, Associate Deputy Chief for Research. Dr. Philpot has worked extensively in acidic deposition research and serves as a member of the Interagency Science Committee in the National Acid Precipitation Assessment Program (NAPAP).

H.R. 2399, the Forest Ecosystems and Atmospheric Pollution Research Act of 1987, would amend the Forest and Rangeland Renewable Resources Research Act of 1978 to require the Secretary of Agriculture to undertake a comprehensive 10-year program related to atmospheric pollution and forest ecosystems. The Secretary would also be required to establish a multi-disciplinary committee of scientists to advise him in developing the program. The committee would be composed of representatives from Federal and State agencies, private interests, and organizations. The Secretary would also be required to coordinate the program with other existing research efforts and to submit reports to the President and the Congress; including an initial Program Report not less than 30 days before establishing the program, an Annual Report by January 15 of each year, and a Final Report within ten years of the Initial Program Report.

We do not believe that H.R. 2399 is necessary because the Forest and Rangeland Renewable Resources Research Act provides adequate authority for the research directed by H.R. 2399.

Both the Administration and the Congress have supported increased research on acidic precipitation and associated airborne pollutants in the past. The Forest Service is currently conducting an extensive atmospheric deposition research program and plans to increase its' effort on forest response to atmospheric stresses. This research includes Federal and State agencies, private interests, and organizations cooperating together to study the effects of atmospheric deposition on selected forest types. I would like to briefly describe our current program.

The Forest Service first conducted research on airborne pollutants in the early 1960's. This research dealt primarily with the effects of ozone and other gaseous pollutants on forest ecosystems in southern California, the Southeast, and the Midwest. This research has led to a better understanding of the mechanisms and effects of some airborne pollutants on tree growth and mortality. In 1982, the Forest Service began to expand its air pollution research program as part of the National Acid Precipitation Assessment Program (NAPAP).

The National Acid Precipitation Assessment Program was created by the Acid Precipitation Act of 1980. The goal of NAPAP is to develop an objective and comprehensive scientific information base for decision makers concerned with possible effects of atmospheric deposition on the Nation's resources. The National Oceanic and Atmospheric Administration, Environmental Protection Agency, Department of Agriculture, Department of the Interior, and the Department of Energy all participate in and support the overall program. The Department of Agriculture is the lead agency for the Terrestrial Effects Task Group (Task Group V), and is coordinating the interagency research effort on effects of atmospheric deposition on terrestrial ecosystems. The general research questions addressed by Task Group V are: "What are the effects of atmospheric deposition on agricultural crops and forest condition, and what components of atmospheric deposition are involved?" The key policy questions center on the possible effects of sulfur and nitrogen compounds, although ozone and other airborne anthropogenic pollutants are also being evaluated.

Much of the concern about possible effects of atmospheric deposition on U.S. forests stems from current observations of forest decline in European countries and the Eastern United States. Forest decline is a general term connoting a decrease in the health and vigor of forest tree species, possible death of individual trees, and a resulting disintegration of forest biotic communities. Declines are caused by a combination of stress factors interacting to produce an effect that no single factor can accomplish alone.

In central Europe a severe, rapid, and widespread forest decline is occurring. This condition is generally thought to be partly a result of air pollution. In the eastern U.S., some decline has been observed in spruce trees in the spruce/fir forest type. Symptoms, including significant defoliation and death of individual trees, are most apparent at higher elevations in the Appalachian Mountain chain at locations such as Camel's Hump, Vermont and Mount Mitchell, North Carolina. Reductions in tree diameter growth rates have also been observed for loblolly, shortleaf, and slash pines in the Southeast as well as red spruce in the Northeast. These changes in forest condition could result from many naturally-occurring stresses including climate, short-term weather events, insects and diseases, the intensity of forest management, and forest age. These changes could also be caused or influenced by atmospheric deposition. However, there is currently no conclusive evidence that atmospheric deposition is involved in the observed U.S. decline.

We began a focused research program in 1985 to determine the extent and location of forest conditions that might be related to atmospheric deposition, and to determine what role atmospheric deposition plays in influencing the conditions of U.S. forests. This "Forest Response Research Program" is jointly planned, managed, and funded by the Forest Service, Environmental Protection Agency, and forest industries (through the National Council of the Paper Industry for Air and Stream Improvement). The program has four major components: (1) research cooperatives for four major U.S. forest regions, (2) a National Vegetation Survey, (3) an Atmospheric Exposure Monitoring program, and (4) an overall data synthesis group.

The four research cooperatives, involving the Forest Service, Environmental Protection Agency, forest industries, and universities, are studying the effects of atmospheric deposition on selected U.S. forest regions (eastern spruce/fir, southern commercial pine, eastern hardwoods, and western conifers). The research is designed to determine if atmospheric deposition is causing changes in forest conditions, what agents and mechanisms are causing the effects, and what effects are possible in the future under varying deposition rates.

Studies are testing specific hypotheses of forest response to airborne pollution. Hypotheses now being tested include consideration of nutrient leaching from tree foliage and soils, toxic metal mobilization in soils and uptake by trees, excessive deposition of nitrogen and sulfur, effects from exposure to phytotoxic gases (such as ozone), and interaction of atmospheric deposition with other environmental stresses. Research will include studies under controlled laboratory, controlled field, and uncontrolled field conditions at a small number of intensive sites. The antire research program is structured to simultaneously investigate a number of working hypotheses, quickly eliminate implausible hypotheses, efficiently focus allocated resources and scientific effort on the remaining hypotheses, and provide a mechanism to input new hypotheses as research progresses.

Research programs for eastern spruce/fir and southern commercial pine forest types were initiated in FY 1985 and are ongoing. The Forest Service's Northeastern Forest Experiment Station and the Southeastern Forest Experiment Station, respectively, are responsible for theas two research cooperatives. Plans for research programs in eastern hardwoods (at the Forest Service's Northeast Forest Experiment Station) and western conifers (managed by EPA's Environmental Research Laboratory in Corvallis, Oregon) were completed in FY 1986 and are being implemented this year. Joint planning and management of the four research cooperatives between the Forest Service, the Environmental

Protection Agency, and forest industry will continue for the life of the program. Most of the ongoing studies in all four regions are multi-year efforts.

The National Vegetation Survey is managed by the Forest Service's Southeastern Forest Experiment Station in Research Triangle Park, North Carolina. The goal is to determine the extent, location, and severity of changes in forest conditions that might be related to atmospheric deposition. Survey activities currently are concentrated in the eastern U.S. The survey will provide an understanding of overall forest conditions and identify/generate long-term forest health information which will be used for extrapolating results obtained from the forest research cooperatives.

The Deposition Monitoring Support Program provides site-specific atmospheric deposition and meteorological information to assist the research cooperatives in determining cause/effect relationships between atmospheric deposition, other environmental stresses, and forest responses. This program component is managed by the EPA Environmental Monitoring Systems Laboratory at Research Triangle Park, North Carolina.

The overall data quality and synthesis group coordinates several program-wide functions and has two components. The Quality Assurance (QA) Project provides guidance and assistance to researchers in implementing a program for each project that assures comparability of data across sites and over time. The QA program also demonstrates data quality through quantitative and qualitative evaluations of the research projects, The Synthesis and Integration (S&I) Project combines individual project and cooperative-level results to provide quantitative estimates of forest response to acidic deposition and associated airborne pollutants. The long term goal of this project is to estimate regional forest responses under varying pollutant burdens.

In addition to playing a major role in the cooperative Forest Response Research Program, the Forest Service has also established two additional research programs in the wastern U.S. as part of the Department's airborne pollutant research effort. The effects of atmospheric deposition on alpine and subalpine ecosystems in the Rocky Mountains are being investigated at the Forest Service's Rocky Mountain Forest and range Experiment Station in Fort Collins, Colorado. Effects of photo-oxidents (i.e., ozone, PAN or peroxyacetylnitrate, etc.), nitrates, and other airborne pollutants on commercial forests in the Sierra Nevada Mountains are being studiad at the Pacific Southwest Forest and Range Experiment Station's Riverside, California laboratory. This expands the long-standing research program on air pollution effects on forests in the Los Angeles Basin.

Presently, with the exception of demonstrated ozone damage to forests in California, there is insufficient data to conclusively state that atmospheric deposition is, or is not, causing adverse changes in U.S. forest conditions. However, existing circumstantial evidence suggests that atmospheric deposition may be involved in some regional forest decline situations. The Forest Service's air pollution research activities and level-of-effort reflects the Administration's position to support research on acidic precipitation so that pressing policy questions regarding the control of air pollutants can be answered using scientifically-sound, legally-defensible data.

The Forest Service is also concerned about other, larger-scale influences which may directly affect the health and growth of U.S. and North American forests during the next 100-200 years. We are initiating a research planning effort to address potential forest effects from a wider range of anthropogenic contaminants, and to investigate forest ecosystem changes stemming from global-scale warming trends, and increased atmospheric CO_2 concentrations. This ten-year program would build on our current atmospheric deposition research efforts and expand to the broader concerns after 1990.

Mr. Chairman, this concludes my testimony. Dr. Philpot and I will be pleased to answer questions that you or members of the subcommittee may have on this program.

STATEMENT OF
DONALD J. EHRETH
DEPUTY ASSISTANT ADMINISTRATOR
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON FORESTS, FAMILY FARMS, AND ENERGY
OF THE
COMMITTEE ON AGRICULTURE
HOUSE OF REPRESENTATIVES

JUNE 9, 1987

Good afternoon, Mr. Chairman. I am here to represent the U.S. Environmental Protection Agency (EPA). In my remarks, I want to emphasize three points about EPA's role in management of the research program on effects of atmospheric deposition on forests: the policy-relevant nature of the design of an effective forest response program; EPA's history of scientific and research management expertise in programs of similar complexity; and the necessity to continue the cooperative efforts of EPA and Forest Service scientists under the current program framework to assure the output of high-quality information.

To support these points I will discuss the state of knowledge of the effects of acid deposition on forests, EPA's contribution to research on the effects of air pollution on crops and forests, EPA's participation in the Forest Response Program as part of the National Acid Precipitation Assessment Program (NAPAP), and expected near-term results of this program. After my presentation, I will be glad to respond to any questions you may have. I have with me today Dr. Courtney Riordan, Director of the Office of Acid Deposition, Environmental Monitoring and Quality Assurance and member of the Executive Committee of NAPAP, who will assist me as necessary.

Acid Deposition Effects on Forests

Until 1983-1984, the primary concern about the environmental effects of acid deposition was potential acidification of surface waters and resulting decline or elimination of aquatic biota. This issue represented both the policy debate and primary focus of the research program. However, several developments highlighted forest health as a major area of scientific concern. These developments led the EPA Administrator to decide that there was a need to greatly expand the existing national acid deposition research program to address the potential effects of acid deposition on forests.

The developing situation in central Europe was a major factor in this shift. Adverse changes in forest condition have been observed in forests throughout the Federal Republic of Germany (FRG) since the early 1970's and in many other regions of central Europe since the early 1980's. These symptoms were observed first on silver fir in so-called "clean air regions" of southern Germany. Later, similar symptoms were observed in widely distributed stands of Norway spruce, the most important commercial forest species in the FRG and much of central Europe. Apparent injury to several deciduous tree species and to other economically less important conifer species has also been observed.

While factors affecting forests in Europe may be very different from conditions in the U.S. or elsewhere, apparent decline of European forests aroused concern here. In the U.S. several reports indicate that red spruce has been experiencing a decreased growth rate and significantly increased mortality at numerous high-elevation sites thoughout the Appalachian Mountains over a period of 20 to 25 years. Foliar symptoms such as loss of foliage, premature senescence of foliage and reductions in fine root biomass have also been observed in these forests. These adverse changes in forest condition are more prominent at the higher elevations where trees are exposed to cloud and fog for extended periods of time. Several factors including atmospheric deposition have been suggested as potential causes of these changes in condition. Recent research has emphasized the importance of natural stress factors in understanding the potential role of acid deposition and associated pollutants in these declines. For example, studies in the southern Appalachians indicate that a vast majority of fir mortality can be attributed to balsam woolly adelgid. Also, recent reports of decreases in the radial growth of low elevation red spruce over a 20 year period have been attributed to natural stand dynamics. However, the study could not rule out atmospheric deposition as a causal or contributing factor.

Apparent growth reduction of several southern pine species is also causing concern. The average annual radial increment of young pine trees has been reduced in southeastern pine forests during the last 20 years. Whether air pollutants, including acid deposition and ozone, are producing these growth reductions is unknown at this time and is the subject of extensive ongoing research. Recent information for these activities indicates the importance of natural factors and interactive effects.

EPA's Responsibilities and Research into the Effects of Air Pollution and Atmospheric Deposition on Forests and Crops

Under the Clean Air Act (CAA), EPA has the responsibility for protecting the Nation's health and environment from the adverse effects of air pollution. The CAA requires extensive scientific and technical knowledge and expertise to achieve its goals. As a part of this responsibility, the EPA maintains research programs to determine the direct and indirect effects of gaseous pollutants and atmospheric deposition (the wet deposition and dry depostion of gaseous pollutants and particulates) on human health and ecosystems.

Over the years the EPA has been a leader in planning, funding, and managing the major studies which have incorporated a multi-disciplinary, total-ecosystem approach to studying the effects of air pollution on agriculture, forests, and aquatic ecosystems.

EPA has long recognized the potential effects of gaseous pollution on agriculture. From its inception, EPA has supported studies to determine the influence of O_3, NO_2, SO_2, and hydrogen fluoride alone or in combination on foliar injury and growth of agricultural crops. The EPA also initiated the National Crop Loss Assessment Network (NCLAN) in the late 1970's to develop pollutant dose-response information for economically important crop species. The major thrust of the NCLAN program has been to determine the effects of O_3 on crop yield and incorporate these findings in econometric models to predict potential effects on the national economy.

EPA's concern that ozone might be causing a decline in the San Bernardino National Forest of southern California led to the implementation in the mid-1960's of a large ecological study to determine the nature of the decline. The study confirmed that ozone was the cause of the foliar injury, premature leaf drop, decreased photosynthetic capacity, reduced radial growth, and death by bark beetles that was observed in ponderosa and Jeffrey pine.

Additional air pollutant impact studies funded by the EPA include the Colstrip Project which determined the influence of SO_2 on a representative grassland ecosystem in Montana, a Forest Experiment Station study in Ohio which investigated O_3 and SO_2 injury on eastern white pine, and a Forest Experiment Station study in North Carolina which investigated O_3 and SO_2 effects on southeastern conifers. More recently, EPA founded several pilot studies, under the auspices of NAPAP, which brought to light the decline occurring in high elevation spruce-fir forests in the eastern U.S.

As a result of EPA's experience and expertise in the study of air pollutant effects on vegetation, the Agency provides capability that is unique and essential to the manangement and implementation of a responsive program to determine the effects of atmospheric deposition on forests.

Since 1980, EPA has worked jointly with other Federal agencies in planning and implementing a NAPAP research program that is aimed at providing answers to the scientific questions that are most relevant to the establishment of policy on the issue of acid deposition. By the summer of 1984, the Administrator of EPA had decided that the EPA/NAPAP research program had to be expanded and carefully targeted to respond to a number of basic questions concerning the existence of possible causes (especially acid deposition) of forest damage in the U.S. The Administrator and the Secretary of Agriculture agreed that researchers in EPA and the Forest Service should work together to design and implement an interagency research program. To expedite the program, he approved a reprogramming of $1.5 million of EPA research funding in 1985 to be devoted to the joint Forest Response Program.

At the same time the Administrator, in his capacity as Joint Chair of the NAPAP program, led the effort to expand this forest effects research in the FY 86 Presidential Budget request to Congress. As a consequence of the planning effort by EPA and Forest Service scientists and managers, we now have a jointly funded and managed Forest Response Program totaling $20 million in FY 87.

The Joint EPA/Forest Service Research Program

EPA and the Forest Service have jointly developed and implemented the Forest Response Program. These two agencies, working under a formalized Interagency Agreement, share the unified goal to determine: (1) if atmospheric deposition is causing or contributing to forest damage is the U.S., and if so, (2) the causes and mechanisms, and (3) the dose-response relationships between forest damage and atmospheric deposition.

This program is closely coordinated with research activities at the State and regional level and has close ties to the forest products industry through tha National Council for Air and Stream Improvement (NCASI).

Four Research Cooperatives were organized in 1985 and 1986 to conduct research in the eastern spruce-fir, southern commercial pine, eastern hardwood, and western coniferous forests of the U.S. The Spruce-fir and Southern Commercial Forest Research Cooperatives focus research on causes of visible damage or growth declines currently observed in these forests. Such activities involve characterizing forest damage, conducting controlled screening experiments, and testing hypotheses of decline. The National Vegetation Survey and the Atmospheric Exposure Cooperative provide survey and monitoring support, respectively, for these cooperatives.

The Eastern Hardwoods and Western Conifers Cooperatives are engaged in problem definition studies to determine if there is a potential for effects of acid deposition or associated pollutants on these forests. In both the laboratory and the field these cooperatives are studying tree species for sensitivity to acid deposition and other pollutants.

Coordination of such a major research effort is assured by the National Program Management, an executive oversight panel, and a central Synthesis, Integration and Data Management team. A strong centralized quality assurance/quality control program has also been instituted.

The accomplishments of this effort to date include:

- Establishment and characterization of 5 high elevation and one low elevation spruce-fir sites.
- First year of data on the exposure of high elevation spruce-fir forests to clouds and the characterization of high elevation deposition chemistry.
- One full season of controlled exposure data on several northeastern, southeastern, and western tree species.
- Extensive analysis of growth patterns in low elevation red spruce.
- Compilation of atlases containing past climate, soil, tree speciation, and chemical climatological data for the southeast and the implementation of a similar project for the northeast.
- Survey of forest condition in Pennsylvannia, Michigan and Minnesota.
- The implementation of projects which should allow the extrapolation of specific mechanistic research to a regional assessment of the effects of acid deposition and associated pollutants on forest health.

I want to stress again that the Forest Response Program has been designed to make the most of the expertise that resides in both the EPA and the Forest Service. As a result of my direct involvement with the design of some of the critical organizational, as well as substantive, aspects of the program, I can say with conviction that had the program been designed by one of the Agencies alone--be it either EPA or the Forest Service--it would not be as effective. Establishing fresh approaches and having to address new questions; rethinking management relationships; and integrating and linking external and internal research efforts has, in my opinion, been a creative and useful process. I believe that we have created a program of the highest scientific quality that is responsive to the research needs of policymakers.

Expected Near-Term Results

Within the next one to two years the Forest Response Program will make much progress toward answering such policy questions as, is there a problem due to acid deposition and associated pollutants, and if so, what are the mechanisms and the dose-response relationship.

Within the next one to two years we expect:

- results of screening studies for susceptibility to acidic deposition and other air pollutants in spruce-fir;
- determination of the most plausible mechanisms of the effects of acid deposition or air pollutants on spruce-fir and southern commercial pine;
- estimation of the range of forest damage in spruce-fir and southern commercial pines; and
- determination of the potential for adverse effects of acid deposition and associated air pollutants on eastern hardwoods and western conifers.

Concluding Comments

In conclusion, I would re-emphasize three points that are critical to understanding EPA's role in the research program for determining the relationship between atmospheric deposition and forest effects. My first point has to do with the very essence of the research itself. Research must be designed to address the scientific questions of principal concern to policymakers. The EPA Administrator has been diligent in holding EPA research managers and scientists accountable for achieving such a design, both within their own programs and in the joint program with the Forest Service. Without that kind of direct line responsibility for performance, a research program can stray from its intended objectives.

My second point is that EPA has a long and successful history of carrying out research on effects of atmospheric deposition on crops and forests. EPA has accumulated not only scientific expertise but also research management expertise. The latter is indispensable to the design and implementation of research programs that incorporate integrated short-term and long-term approaches needed to supply knowledge required for rational development of policy.

Finally, I have conveyed my conviction that the research partnership between EPA and the Forest Service will be a great success. The Forest Response Program has enhanced research in both agencies and quality results will emerge both in the short-term and long-term. These incremental improvements in knowledge will provide the Administrator of EPA necessary information as he evaluates the need for additional regulatory actions.

Under this program's framework both EPA and Forest Service can continue to refine our knowledge of the atmospheric effects on forests as needed. Therefore, we believe that enactment of H.R. 2399 is unnecessary.

Mr. Chairman, that concludes my prepared remarks. I would be pleased to answer any questions the Subcommittee may have.

CONGRESSIONAL TESTIMONY
Dr. R. I. Bruck
June 9,1987

- FOREST DECLINE RESEARCH A COMPLEX DISEASE SYNDROME WITH NO QUICK ANSWERS -

A statement prepared for presentation to the

United States House of Representatives Committee on Agriculture

Subcommittee on Forests, Family Farms,

and Energy in Support of HR 2399

June 9., 1987

by

Dr. Robert Ian Bruck
Associate Professor of Plant Pathology and Forestry
North Carolina State University
Raleigh, NC 27695

THE CONGRESSIONAL RECORD OF

THE UNITED STATES OF AMERICA 100[1]:(000,000)

EXECUTIVE SUMMARY

Mr. Chairman and Members of the Committee,

I appreciate the opportunity to appear to before you today to testify on behalf of HR 2399 before the House of Representatives to continue support for forest decline research. My name is Dr. Robert I. Bruck, I am Associate Professor of Plant Pathology and Forestry at North Carolina State University in Raleigh. I bring to you today, eight years of experience in conducting research on effects of atmospheric deposition on forest ecosystems. My research into the potential cause and effects of air pollution damage to American forests has received a number of Federal Grants. The continuation of a long term Federal Research Program to address the issue of forest health in the United States is essential.

It must be emphasized that the contemporary issue of forest decline is an extremely complicated one. The mortality of trees observed across large areas of Central and Eastern Europe over the past six years has been alarming. Despite the large amount of research initiated over the past few years to discover the causes of forest decline at this time there is no scientific consensus as to the primary and/or secondary trigerring agents of this syndrome. The forests of Eastern and Central Europe appear to be threatened by a mysterious combination of natural factors including climatic variation pests, pathogens, in addition to a virtual "vegetable soup" of anthropogenic airborne pollutants, seem to be implicated as either being primary or secondary stress factors at this time. Recent evidence included in my written testimony suggests that similar processes have been and continue to undermine the health of North America high elevation eastern coniferous boreal montane forests.

Although much is not known the stakes are high. The extent of destruction is of great concern. Today nearly 6 million hectares of forest have been disturbed and affected by forest decline in the five countries of West Germany, Austria, Czechoslovakia, Poland and Yugoslavia. Other damages have also been reported throughout the Netherlands, Eastern and Central Europe.

The first signs of this unique disease phenomenon appeared to show up in the early 1970's in West German white fir (Abies alba). However in West Germany in the late 1970's the decline syndrome spread to Norway spruce (Picea abies). And by 1980 it was apparent that a new type of forest decline symptom was being observed which was unprecendented in the literature. Recent research has revealed that coniferous forests in both North America and Europe have been under continuous stress for at least the last three decades. Increment cores taken from thousands of Southern Appalachian conifers over the past few years show that their annual growth rings i.e. increment growth have become markedly narrower since a period of approximately 1958 to 1963 and continuing to the present. Other than balsam wooly adelgid on fir, no significant pests or pathogens have been determined. BIn some illustrated severe cases such as Mt. Rogers in Virgina and Mt. Mitchell in North Carolina the growth rates of red spruce and Fraser fir have been severely stunted. The radial growth of red spruce on Mt. Mitchell at high altitudes has decreased an average of 82%, a five-fold decrease since the early 1960's.

Although there is no concrete scientific consensus as to the cause and effect etiologies of forest decline there appear to be four broad areas of agreement among scientists working on the forest decline issue. These include:

1) Forest decline must be understood as a disease syndrome induced by multiple factors involving several predisposing and stress inducing factors followed by numerous secondary effects of abiotic and biological origin.
2) The primary causes are not due to insect or known forest pathogens although these agents do play an important secondary role in destroying predisposed trees.
3) Climatic factors such as drought and frost may also be involved but their role is probably secondary.
4) The atmospheric deposition of air pollutants or pollutant related toxic, nutrient, or growth altering substances are among the primary suspects of the decline syndromes in a particularly high altitude forests.

One of great frustrations to forest scientists involve the fact that different forms of anthropogenic air pollution are deposited at varying rates in different ecosystems. Some of the hypotheses involve:

1) Ozone damaged and decreased photosyntheses efficiency.
2) Ozone damage in combination with acid rain causing foliar leaching of nutrients.
3) In certain locations direct damage by sulphur dioxide fumigation.
4) Foliar fertilization and increased winter injury primarily due nitrogen compound deposition.
5) Foliar fertilization and altered nutrient allocation again due to nitrogen compounds.
6) Growth altering organic substances.
7) Nutrient leaching from foliage i.e. acid deposition.

8) Nutrient leaching from soil due to acid deposition.

9) Aluminum mobility and toxicity caused by deposition of acids and,

10) Heavy metal toxicity due to the deposition of heavy metals into remote ecosystems and their mobilization by increased soil acidities.

Any and/or all of the above mentioned hypotheses may in fact be involved with the deterioration of spruce/fir ecosystems both in Europe and the Eastern United States.

It stands to reason that a disease syndrome as complex and wide spread as forest decline requires a comprehensive and multi-staged response. It is the opinion of this witness that the burden for research programs must be borne by the Federal Government in the United States. There is little doubt that sulphur and nitrogen oxide emissions throughout the Eastern United States are large, but they may only be part of the forest decline problem or perhaps not a part of the problem at all.

Most studies both in Europe and North America on the detrimental effects of air pollutants on forests have been made near and around large emissions sources. Far less is known about the effects of acid deposition and other air borne chemicals on broadly dispersed forests and long distance transported chemicals.

If and only if sufficient time and stability of funding sources can be provided significant progress could be made over the period of approximately a decade in discerning cause and effect relationships in forest decline syndromes. We need to learn in far greater detail about the responses of forest ecosystems to natural and anthropogenic stress before we can even dream about coming up with broad cause and effect answers. The scientific standard of rigorous proof in discerning cause and effect relationships are far down the road at this time. We must generate large and integrated data sets concerning natural processes and their effects on forest ecosystems. In addition we need to be able to make better predictions on the influences of airborne sulphur, nitrogen and acidic substances on nutrient cycling processes and the potential effects of regional concentrations of ozone and other air toxics on the physiology and growth of spruce and fir forests. These data must be integrated into descriptive and quantitative models to predict tha influences of exposure to anthropogenic pollutants. The current Federal Research Programs as they are devised will not be able to provide the information necessary to make wise decisions as to whether or not air borne pollutant emissions need to be further regulated. I believe by the termination of the 1991 NAPAP program there will not be sufficient proof that one or several air pollutants can cause decreases in productivity and damage to spruce/fir ecosystems in North America. Although much controlled and experimental work will have been accomplished by that time rigorous proof will also not be available concerning the mechanisms of controlled exposure studies and how they are influencing whole forest natural ecosystems. Only through long term and highly coordinated and integrated research programs can we hope to find the answers to these complex questions.

Modern day forest scientists are challenged with a very unique problem, the problem being to provide Congress, Legislators, Regulators, and Policy makers with sound answers so that proper legislation may be adopted to protect our most important natural renewable resource i.e. American Forests. The problem is further compounded by the fact that we must now study ecosystems that at least in the case of red spruce can grow and evolve over 400 years of time. For decision makers to ask scientists to provide them with answers to such a complex enigma within a period of 3 to 5 years is in the opinion of this witness, not responsible.

There is no doubt that the cost of a long range and integrated program for research and development will be high. The solutions remain before this committee today and may ultimately depend on a narrowing of the dichotomy between rhetoric and reality in persuading the decision makers to mandate sound research and environmental management programs. The cost of research is high but it probably represents only a fraction of the cost of controlling air pollution on a wide scale. The cost therefore of making foolish and uninformed decisions could be far greater and perhaps the cost of not doing so could be astronomical in terms of the ecological and economic damage to American Forest Resources. A far greater and integrated research program needs to be mandated post haste. It is my hope that this sub-committee begins to take action today to initiate such programs.

(Attachments are held in the committee files.)

TESTIMONY OF

DR. BENJAMIN B. STOUT,

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC.

Mr. Chairman and Members of the Committee:

I am Benjamin B. Stout, National Program Manager for Air Quality and Forest Health for the National Council of the Paper Industry for Air and Stream Improvement, Inc. known as "NCASI". This organization is the research arm of the forest products industry.

Before addressing future research needs, it might be useful to review the state of the existing research program on air quality and forest health.

National Acid Precipitation Assessment Program

Since the National Acid Precipitation Assessment Program (NAPAP) was authorized in 1980, we have seen the Forest Service and the Environmental Protection Agency (EPA) develop research programs that are coordinated with the forest products industry--through NCASI--and the electric power industry, through the Electric Power Research Institute (EPRI). The coordination, missing early on, has produced a positive synergism among the program participants.

Today a substantial research program is in place, supported with public and private funds, to examine questions relating to air pollution to forest health and productivity. During 1987, it is expected that the Forest Response Program, administered jointly by the EPA and the Forest Service, along with the programs of EPRI and NCASI will expend over $20 million in research related to air quality and forest health.

We have learned some things since we started. For example, we originally focused our research solely on the effects of acid rain. It now appears that sulfur and nitrogen compounds may not be having all that much effect on our forests and that ozone, and perhaps other oxidants, deserve more attention. But there is still much that must be known before any conclusions can be reached. And to get these answers, we must broaden the scope of our research.

Mr. Chairman, I hope this does not give the impression that we are dissatisfied with the current NAPAP structure or program. NAPAP was a response to an immediate need and was based on the best knowledge available at the time. Its program management structure has proven very effective in coordinating the research efforts of the EPA, the Forest Service and the private sector. Although we consider the limited scope of the research restrictive, we have, through proper coordination, been able to move toward many of our initial research objectives.

Future Concerns

However, the future concerns us. Specifically:

- There are those who would argue that the focus of NAPAP should be narrowed to just acidic deposition and that other programs should work on pollutants such as oxidants;
- The NAPAP authorization is scheduled to expire in 1990 and potentially with it much of the hard-won research coordination currently in place; and
- The forces of agency autonomy are acting to produce essentially distinct efforts in forest effects research with regard to air pollutants. I refer specifically to an ozone program being developed in EPA that is outside of the existing NAPAP effort.

H.R. 2399

Mr. Chairman, as the committee considers H.R. 2399, we urge that the following be kept in mind:

- Many of the actions specified in the bill already are being addressed by the Forest Service. For example, forest inventory work is underway to determine methods for quantifying trends in forest health and productivity. Also, a national research plan for the Forest Response Program has been developed within the NAPAP structure that lays out long-term research needs. And the current NAPAP Forest Response Program structure effectively fosters the needed cooperation among Federal, state, and private researchers.

- After NAPAP's scheduled termination date in 1990, there will be a continuing need to foster coordination of Federal, state and private research efforts.

- The existing focus of forest health research on acid rain should be expanded to include ozone, heavy metals and other air pollutants.

- And finally, there is the need to have stable, long-term funding for our research efforts. Research, particularly that related to forest health and air quality, requires a long-term commitment. It is not something that can be turned on and off like a light switch and remain effective.

Mr. Chairman, let me emphasize that my purpose today is to speak to the long-term research needs and to urge that the money appropriated for research is used in the most prudent way possible. Recent experience has shown that federal agencies with very different missions can cooperate to conduct an integrated forest effects research program. From the standpoint of an industry that is dependent on productive forests and one that contributes to the research effort, we hope that this will continue.

I appreciate the opportunity to offer these comments and I will be happy to answer any questions.

Statement by Don Hinrichsen, Editor-in-Chief, World Resources Report--a joint publication of the World Resources Institute, Washington DC and the International Institute for Environment and Development, London.

Mr. Chairman, members of the subcommittee, distinguished colleagues, ladies and gentlemen...

I want to thank the subcommittee for inviting me to testify today on the subject of air pollution and forest decline.

Since my last appearance before this subcommittee in May of 1986, the forest declines observed across large areas of Europe and the eastern United States have accelerated--both in terms of the areal extent of damage and the severity of that damage.

It is now estimated that at least 8 million hectares of forests have been stricken by Waldsterben, or forest death, in 15 European countries. The World Commission on Environment and Development recently put the damage at about 15 percent of the total forested area of western Europe.

West Germany is still hardest hit with some 54 percent of its forests, or 3.8 million hectares, affected by Waldsterben. The forest decline syndrome is also increasing in extent and severity in Switzerland, Austria, Czechoslovakia, Poland, East Germany, France, Italy, Yugoslavia, and Sweden.

During 1985-86, Swiss forests were particularly affected. Overall, at least 36 percent of the country's forests are currently damaged by Waldsterben, with the most severely affected regions in the Alps, where trees are vital barriers against avalanches. Switzerland's Federal Office of Forestry reported that the disease syndrome has attacked or killed some 43 percent of the trees in the central alpine region situated between the French and Italian borders to the south and west and the Austrian border to the east.

The forest declines observed in Poland, the German Democratic Republic, and Czechoslovakia are thought to be far more severe than official figures indicate. Unofficial estimates place the amount of damage at up to 1.5 million hectares for Poland, 2.5 million hectares for the German Democratic Republic, and more than 1 million hectares for Czechoslovakia.

North America's higher elevation eastern coniferous forests have also experienced a rapid and severe deterioration since 1983-84. The most severely affected areas are in the Appalachian Mountains

2,

from Georgia to New England.

A six-state study in the southern Appalachian region recently revealed that Eastern white pine is suffering from pollution-related declines in 23 percent of the stands surveyed. The area with the highest incidence of decline was in Kentucky, where 77 percent of all the white pine surveyed showed air pollution damage. Even more alarming is the finding that trees with air pollution damage were growing 49 percent less volume on the average than healthy trees. The main pollutant known to damage white pine is ozone, along with other photochemical oxidants.

An extensive research program is also underway on Mount Mitchell, North Carolina, to study the widespread decline of both Fraser Fir and red spruce noted over the past three years.

Although there is little or no consensus yet as to the primary triggers in this process, a growing body of research has given rise to six distinct "schools of thought" on the role air pollution might play in forest declines. These include:

1) The general stress hypothesis, in which a multitude of pollutants react synergistically or in an additive manner to induce the damage;

2) Soil acidification-aluminum toxicity, which postulates that the wet and dry deposition of acidified particles is the main cause;

3) Ozone and other photochemical oxidants, known to induce needle and leaf damage on trees;

4) Magnesium deficiency, which holds that pollutants leach essential elements for growth out of the soil, leaving the trees starved for food;

5) Excess nitrogen or excess nutrient deposition, which postulaters that over-fertilization from airborne fallout of nitrogen compounds (for example, from fertilizers) is inducing the trees to grow too fast, causing a breakdown in their metabolic processes; and

6) The deposition of growth-altering organic chemicals like aniline and ethylene which can produce the bizarre dieback symptoms seen throughout Europe and on some higher elevations in North America.

Out of these 6 "schools of thought" have emerged 10 specific damage mechanisms whereby airborne chemicals may contribute to forest decline and death.(See testimony from last year for details).

With so many suspects to choose from, it is hard for policy makers to formulate effective policies, especially since much more fundamental field and laboratory research remains to be done before scientific investigators manage to come up with some answers, instead of more questions. What this means, however, is that no single pollutant control strategy is likely to be effective in dealing with Waldsterben. It will take nothing less than a total integrated mix of strategies and technologies tailored for each region to improve air quality in Europe and North America significantly.

Thank you.

AMERICAN FORESTRY ASSOCIATION
Founded 1875 P.O. Box 2000 Washington DC 20013 telephone (202) 467-5810

Testimony of

R. Neil Sampson
Executive Vice President

before the

House Agriculture Committee

Subcommittee on Forests, Family Farms, and Energy

June 9, 1987

Mr. Chairman and Members of the Subcommittee:

I am Neil Sampson, Executive Vice President of the American Forestry Association, the national citizens conservation organization for trees, forests and forestry. I am pleased to appear here today to present our views on the need for expanded research into the impacts of air pollution on forest health and productivity and express our support for H.R. 2399.

Atmospheric pollution has been identified as a major culprit in the forest damage now occurring in many parts of the industrial world. In recent years the term "acid rain" has captured the attention of the American public. The dramatic effects of acid precipitation on aquatic systems are widely recognized. As information about aquatic effects became more conclusive, attention turned to terrestrial systems, principally trees and forests.

Faced with the compelling accounts of pollution-related forest declines in Europe and domestic symptoms that some observers insist herald the onset of similar forest resource damage in the United States, AFA members have expressed their increasing concern and uncertainty about the future health and productivity of our national forest resources. But as research progresses, it appears that "acid rain" per se is not likely the all-consuming culprit in the forests. Different forms of air pollution, in addition to acid precipitation, pose a threat to forest ecosytems.

In response to these growing concerns, AFA has undertaken the role of "truth broker" on the subject of Forest Health. We have carefully sought out and published information on air pollution and forest health in AMERICAN FORESTS magazine. This information is targeted toward policy makers as well as concerned AFA members and the general public.

The National Citizens Organization For Trees, Forests, and Forestry

The February 1986 issue of AMERICAN FORESTS, for example, contained an article summarizing the current state of knowledge concerning forest declines across the United States and how scientists view the likely combination of air pollution and other culprits. The article presents a discussion of several U.S. forest types that may be experiencing damage from air pollution -- California mixed forests, eastern white pine, Appalachian red spruce, New England sugar maples, Ohio River Valley deciduous species, and southern pines. These forest health problems are presented in order of decreasing certainty and increasing need for further research. A copy of this article is attached to this statement.

AFA recently organized a Forest Health Task Force, composed of AFA Board Members, to examine the current threats to the health and productivity of the nation's forests which air pollution, wildfire, insects and disease pose. The Task Force, which will be guided by an Advisory Panel of forest health scientists and experts, has designated air pollution as its primary initial focus. We are currently preparing an AFA White Paper on the effects of air pollution on forest ecosystems, and plan to publish this report in late July. The report will explore various hypotheses put forth by the scientific community to explain the possible effects of air pollution on the forest ecosystem: trees, water, fish, soil, air and visibility. Although it would be premature to report in detail on this effort, I can say that the paper will call for a greatly expanded forest health research effort and will include recommendations on the subject of increased emissions controls.

Reducing air pollution has become a major goal for the environmental and conservation community; the health and productivity of our forest resources should be of critical concern to every member of our society. A significant problem with the current Forest Response research conducted under the National Acid Precipitation Assessment Program (NAPAP) is, as the effort's name implies, its narrow focus on acid precipitation. Scientists testifying before this Subcommittee in 1986 clearly demonstrated that other air pollutants, in addition to acid precipitation, warrant study with regard to their forest effects. These scientists stressed the need to further study pollutants including ozone and other photochemical oxidants; sulfur dioxide; excess ntirogen deposition; heavy metals such as lead, cadmium, copper, and zinc; and growth-altering organic chemicals such as ethylene.

Comprehensive research is necessary to more fully understand this complex problem and its potential solutions. Continual attention needs to be given to the coordination of past, current and future research efforts undertaken by a variety of government and private entities, to maximize the overall effectiveness of this research, and avoid duplicative efforts. We do recommend, however, that language be included in the bill to indicate that this additional research effort is intended to be funded in addition to, and not as a substitute for, existing agency research efforts.

Such coordinated research is needed to focus attention on forest ecosystems, on both public and private lands, to further the identification of the environmental factors that influence their health and productivity. We must broaden our basic understanding of the current forest situation and associated trends, and then use this information to guide our study of developing trouble spots and potential remedies.

Furthermore, we should not delude ourselves into thinking that eventually there will be an easy answer to this important resource question. As more and more research is done on the problem of forests and their health, it is becoming clear that the situation is more complex than most people have realized. And while comprehensive research can help us sort out the facts of the situation, we will still be faced in the end with the difficult social and political debates, choices, and tradeoffs involved in implementing potential solutions.

The Forest Service, with its technical expertise and research experience, is in the ideal position to do the quality research necessary to better identify and understand threats to forest health. The Forest Service is not, however, in the position to recommend the necessary emissions reductions that might come as a result of the findings of their research.

Such reductions will be a political decision which the Members of Congress must eventually make as the elected representatives of the American people. As an example, Forest Service research may conclude that nitrogen oxide emissions are one cause of the problems, but it will be up to Congress to guide the tough economic and environmental decisions which would be required to reduce this or any other component of air pollution.

The real question at hand, however, is "do we want to make those difficult choices without good information?" If the answer is "no," we need to approve and fund this research. Although there is no guarantee that we will know all we need to know when we need to know it, the research program outlined in H.R 2399 represents a necessary step in the right direction.

We urge the Congress to move forward with coordinated air pollution research legislation, and we stand ready to assist in the explanation and interpretation of this research to the American public.

(Attachment follows:)

FOREST HEALTH

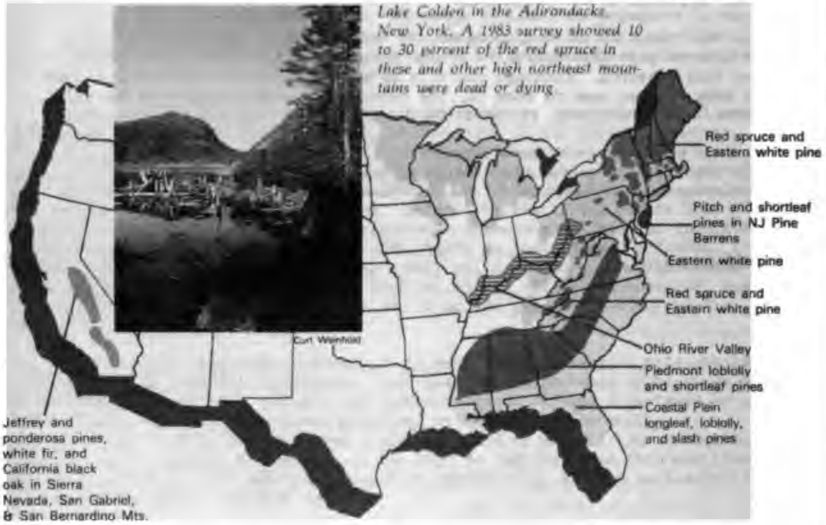
"Acid Rain" and Forests

An Attempt To Clear the Air

A layman's look at forest declines across the U.S. and how scientists view the most likely combinations of culprits.

BY ADELA BACKIEL AND FRANCES A. HUNT

SUSPECTED AREAS OF AIR-POLLUTION DAMAGE TO U.S. FORESTS


Red spruce and Eastern white pine
Pitch and shortleaf pines in NJ Pine Barrens
Eastern white pine
Red spruce and Eastain white pine
Ohio River Valley
Piedmont loblolly and shortleaf pines
Coastal Plein longleaf, loblolly, and slash pines
Jeffrey and ponderosa pines, white fir, and California black oak in Sierra Nevada, San Gabriel, & San Bernardino Mts.

Lake Colden in the Adirondacks, New York. A 1983 survey showed 10 to 30 percent of the red spruce in these and other high northeast mountains were dead or dying.

Curt Weinhold

Scattered growth declines, foliar damage, and mortality of eastern white pines have been clearly linked with ozone and other photochemical oxidants. Ozone levels are relatively high throughout the range of the species.

Damage to Jeffrey pine, white fir, ponderosa pine, and California black oak in the San Bernardino, San Gabriel and Sierra Nevada Mountains of California has been linked to ozone and other photochemical oxidants. Some moderate to severe damage has been reported on the southern slopes of the western part of the San Gabriels, and in the western San Bernardinos, but damage is generally light or nonexistent in most parts of these ranges.

Declines of red spruce in the Appalachian Mountains have been circumstantially linked to air polution.

Decreased growth and foliage changes in pitch and shortleaf pines in the New Jersey Pine Barrens may be attributable to air pollution (suspected) and drought (likely).

Air pollution is considered one of several possible causes (including drought and hardwood competition) of reported growth declines of loblolly and shortleaf pine in the Piedmont, and of longleaf, loblolly, and slash pine of the eastern coastal plain.

Air pollution has been suggested as a possible cause of the damage and death of white pines, maples, oaks, and other species in the Ohio River Valley.

In recent years the term "acid rain" has captured the attention of the American public. The dramatic effects of acid rain on aquatic systems are widely recognized. As information about aquatics became more conclusive, attention turned to potential effects on terrestrial systems, principally trees and forests. But as research progresses, it appears that acid rain per se is not likely the all-consuming culprit in the forests. Different types of air pollution, in addition to acid rain, may pose a more likely threat to forest ecosystems. But research and data on this topic, though incredibly voluminous, are far from conclusive. This article explores various hypotheses put forth by members of the scientific community to explain the possible role of air pollution in declines presently occurring in American forests. The intent of this article is to help communicate the vast array of scientific information about this subject to concerned AFA members and the public.

The current phenomenon of unexplained forest deterioration in West Germany has aroused concern for the health of American forests. (See the January articles "A Walk in the Black Forest" and "Dying Forests: A Tree Lover's Viewpoint.") American forests have periodically suffered ill health, usually resulting from a known cause. Although not of the same magnitude as the deterioration in West Germany, certain American forests are presently suffering decreased health,

---

Adela Backiel is an analyst in natural resources policy for the Congressional Research Service in Washington, DC. Frances A. Hunt is a legislative assistant here at AFA and editor of RESOURCE HOTLINE, the Association's biweekly newsletter that tracks timely issues such as current findings in acid-rain research.

WAYS POLLUTANTS MIGHT AFFECT ECOSYSTEMS

POLLUTANT	HYPOTHESIS	EXPECTED SYMPTOMS	POSSIBLE FORESTS AFFECTED
DEPOSITION OF WET AND DRY ACIDIC SULFUR AND NITROGEN OXIDES (SO_x and NO_x)	Acid deposition may reduce normal nutrient level available to trees: 1) speeding the normal leaching of nutrients directly from leaves or needles. If affected trees cannot sufficiently replace these nutrients, deficiencies can alter normal life and growth processes.	• Yellowing and browning of foliage	• Forests that are frequently cloud or mist-covered and exposed to atmospheric pollution
	2)Acidifying forest soils. As soils become more acidic, nutrients (such as calcium and magnesium) can be removed.	• Soil acidification • Yellowing and browning of foliage	• Forests on nutrient-poor soils
FERTILIZATION BY NITROGEN OXIDES (NO_x)	Nitrogen overfertilization: 1) Too much nitrogen "fools" trees into continuing to grow late in the fall. Winter cold can damage and kill foliage that is not prepared.	• Red-brown discoloration of preceding year's foliage	• High-elevation forests; e.g., red spruce in northeastern Appalachians
	2) Nitrogen-fertilized plants respond by increasing growth above ground, but this is not offset by increased root growth. Total root system may actually be decreased, making tree more susceptible to drought, other stresses.	• Decreased root mass and mycorrhiza	
GASEOUS POLLUTANTS Ozone and Other Photochemical Oxidants	A sudden onset or sharp rise in ozone can damage— or kill leaf cells, leading to decreased photosynthesis, loss of water, and increased leaching or removal of nutrients from foliage.	• Death of cells in leaves and needles • Purple/black on broad-leaves • Premature aging of foliage • Reduced growth	+ White fir, California black oak, Ponderosa, & Jeffrey pines in southern California + White pine, eastern U.S. • Loblolly, and shortleaf pine in Piedmont forests of AL, GA, NC, SC
Sulfur Dioxide (SO_2)	Chronic ozone exposure in combination with acidic rain or fog increases nutrient loss from foliage, which leads to reduced photosynthesis and root growth.	• Yellowing or browning of foliage	• High-elevation forests in Northeast
	SO_2 can enter plant through stomata and react with water to form acids. Acute or chronic exposure can damage or kill cells in leaves, reducing photosynthesis.	• Yellowing or browning of foliage • Often no visible injury • Premature needle loss	• Point-source problems (e.g. smelters in Sudbury, Ontario)
TRACE METALS Aluminum Mobility	As soil acidity rises, aluminum increases to toxic levels and can displace beneficial nutrients, inhibit their uptake, and damage fine root hairs, leading to nutrient and moisture stress.	• Loss of leaves or needles • Soil acidification • Death of fine roots	• No evidence in U.S. (highly suspected in W. German forests)
Heavy Metal Deposition	Metals exist in soils in trace amounts. Excess amounts could interfere with photosynthesis, root growth, and reproduction.	• Slow rate of decomposition	• High-elevation spruce-fir ecosystems in southeastern U.S. • Localized pollution problem areas particularly close to smelters
GROWTH-ALTERING SUBSTANCES	Synthetic organic substances may stimulate abnormal growth and development, particularly in foliage.	• Browning and death of leaves and needles • Loss of green foliage	+ Loblolly pine in North Carolina

+ Denotes general scientific acceptance of linkage to noted causal agent.

vigor, and productivity, with few reasons having surfaced. The present number of these unexplained forest declines and the puzzling circumstances have piqued the attention and emotion of Americans like few other forestry issues.

"If questioned about lakes, my answer would be unqualified—air pollution is a threat. The tour of Mt. Mitchell gave evidence that things are occurring in the forest, but the extent of damage and causes are not known."

DR. ROBERT BOND
Dean of Forest Resources
Pennsylvania State University
(For more comments from forestry school deans, see sidebar on page 6.)

Curt Weinhold

"The term 'decline' means different things to different people," according to Dr. Paul D. Manion of State University of New York at Syracuse. "In its broadest interpretation, tree decline refers to any situation in which the tree gradually deteriorates over time." The term "forest decline" is generally used if more than one species is involved. Unlike a disease in which death is attributed to one cause, such as chestnut blight and Dutch elm disease, a decline is caused by interacting biological and nonbiological stress factors.

Symptoms of decline can be visible or invisible, rapid or progressive, chronic or acute. They can include reduced growth, crown and twig dieback, yellowing, smaller leaf size, thinning and dying needles and leaves, and deterioration of roots. Examples of declines that have occurred periodically over the years in the United States include the decline of ash and maple in the 1930s and the late 1950s, and birch dieback in the Northeast from the 1940s to the 1970s. More recently, red spruce and Fraser fir have been observed to be in a state of decline in the high elevations of the Appalachians; pitch and shortleaf pine in the New Jersey Pine Barrens; Western white pine (pole blight) in the Rocky Mountains; oak in parts of Pennsylvania, Texas, and Virginia; and maples in the North and parts of Canada.

Little debate occurs over whether certain forests are in decline. But this is where agreement among scientists and researchers ends and controversy begins. Numerous declines have been investigated; sometimes answers were forthcoming, sometimes not. Many declines remain unexplained. Some of this uncertainty is due to the fact that forests are one of nature's most complex systems. (See illustration on page 4.) Little is actually known about the natural workings of the forest ecosystem, let alone a stressed or unnatural one. The situation is further complicated by the wide variety of stresses that affect forests, and though each individual tree species and/or forest can respond to these stresses in a different manner, various stresses or declines can produce the same symptoms.

Most forest stresses involve natural substances or situations that a tree or forest encounters, and accommodates, on a daily basis. The situations that cause various stresses can be categorized as biological, physical, or chemical. Biological factors include insects, fungi, and viruses. Physical factors can involve extremes of heat and cold, moisture supply, and high winds; geographic locations; age of the forest; wildfires; and human activities such as prescribed burning, logging, or construction damage like soil compaction. Chemical factors include natural and man-made gases such as sulfur dioxide, nitrogen, and ozone; metals such as aluminum and lead; acidic substances such as sulfuric and nitric acids; and growth-altering organic chemicals such as ethylene.

Because of the resilience of the forest ecosystem, most trees and forests recover from stressful situations. But at a critical time, one factor could—like the straw that broke the camel's back—push a tree, or an ecosystem, from a weak but stable situation to a vulnerable and declining condition.

AIR POLLUTANTS AS A FOREST STRESS

Of all the factors that can stress forests, air pollution is one of the newest that trees and forests have had to accommodate. Air pollutants can add to a short-term or prolonged environmental stress over the complex of interacting natural stresses.

Many studies have shown that local (point-source) air pollution can harm forest growth. However, the effects of regional air pollution are not as well documented. These regional and transported air pollutants may have direct effects on trees through leaves and stems, and indirect effects, primarily through the soil. Some scientists suggest that these pollutants may be harmful singly, or act in combination with each other to have short-term or cumulative long-term impacts from either short or prolonged exposure.

Many forest scientists have come to believe that air pollution makes a tree or forest more susceptible to the array of natural stresses. But very few of the American forest declines can be directly attributed, even in part, to air pollution. The map on page 1 pinpoints declines in which many scientists think air pollution may play a role.

SIGNIFICANT AIR POLLUTANTS

Both natural and chemical compounds can be pollutants when, like a weed in a garden, they are found in the wrong place or in the wrong concentrations, and produce undesirable results that upset the delicate balance of the surrounding environment.

Primary pollutants are directly emitted into the atmosphere, predominantly in gaseous form, and include sulfur dioxide (SO_2), nitrogen oxides (NO_x), and reactive hydrocarbons (RHC)—carbon compounds such as ethylene and gasoline. The burning of fossil fuels—coal, natural gas, and oil—produces a large portion of these pollutants: industrial, utility, and power plants emit large quantities of the SO_2 and NO_x; mobile sources, such as transportation vehicles, are responsible for large amounts of NO_x and RHCs, and petroleum refining and storage produces reactive hydrocarbons. The majority of RHCs, however, are from numerous small items such as paint solvents, pesticides, and dry cleaners. Metal ore smelters can release SO_2, in addition to toxic elements such as lead, cadmium, nickel, and fluoride. Lead also comes from using leaded gasoline.

Secondary pollutants are formed during chemical reactions including the primary pollutants. The most common is acidic deposition, produced when sulfur oxides or NO_x combines with oxygen in the air to form acidic gases or particulates (dry deposition) or, in combination with moisture, can occur as rain, snow, hail, dew and fog (wet deposition, or "acid rain").

Another type of secondary air pollutant—photochemical oxidant—is produced from energy generated from sunlight that triggers reactions involv-

The Forest Ecosystem

Beneath the forest canopy lies an immensely complex and interrelated community of plants and animals which, in conjunction with the non-living components of the environment, are involved in the struggle of life. This is the forest ecosystem. Although ecosystems have an incredible capability to maintain an equilibrium, if any one component is substantially altered, the ecosystem is affected. Understanding this complex web is an essential aspect of understanding the debate over forest damage and decline.

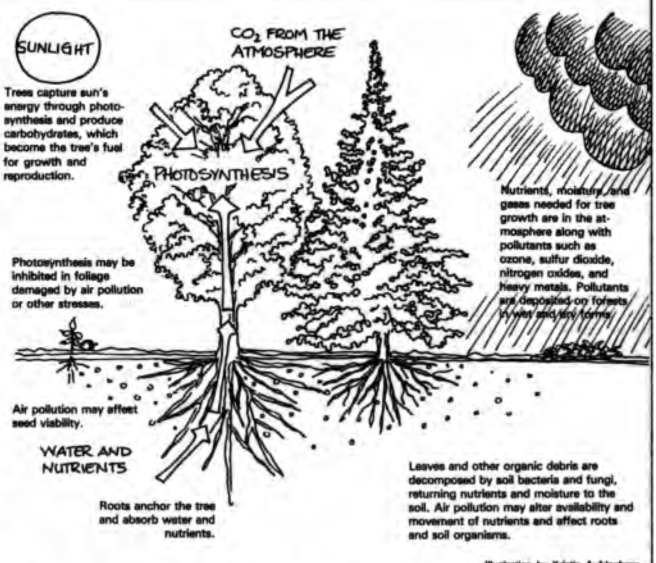

SUNLIGHT
CO₂ FROM THE ATMOSPHERE
PHOTOSYNTHESIS
Trees capture sun's energy through photosynthesis and produce carbohydrates, which become the tree's fuel for growth and reproduction.
Photosynthesis may be inhibited in foliage damaged by air pollution or other stresses.
Air pollution may affect seed viability.
WATER AND NUTRIENTS
Roots anchor the tree and absorb water and nutrients.
Nutrients, moisture, and gases needed for tree growth are in the atmosphere along with pollutants such as ozone, sulfur dioxide, nitrogen oxides, and heavy metals. Pollutants are deposited on forests in wet and dry forms.
Leaves and other organic debris are decomposed by soil bacteria and fungi, returning nutrients and moisture to the soil. Air pollution may alter availability and movement of nutrients and affect roots and soil organisms.

Illustration by Kristin Aufdenberg

Driven by energy from the sun, the substances crucial to life are created, used, and recycled or decomposed so that they can be used again. The life cycle of a forest, or flow of energy, starts with the tree's ability, primarily through its leaves, to intercept light energy from the sun. In the presence of chlorophyll, water, minerals, and gases in the air, food (carbohydrates such as starch and sugar) is manufactured and used by the tree for immediate growth as well as stored for future use. This process is called photosynthesis.

Sixteen nutrients essential for life processes contribute in varying amounts to the growth of plants and are available from both the atmosphere and soil. The soil, in addition to providing support, heat, and air, makes water and nutrients available to be absorbed by the plant's root system, with the assistance of tiny root hairs, which increase the amount of contact between roots and soil. Water and nutrients then travel up the tree through its stems and shoots to the leaves and needles. Removal of nutrients, or leaching, from the foliage and/or soil is a normal part of their nutrient cycling and does not adversely affect the plant as long as losses can be replaced by nutrient up-

Turn to page 7

> *"There may be more publicity and fear of air pollution/acid rain damage than there is actual damage in many cases. We must establish the facts."*
>
> JOHN KUSER *Assistant Professor of Forestry, Rutgers University*

ing NO_x and atmospheric oxygen. Ozone (O_3), the most important oxidant, is a gas that is extremely toxic to both plants and humans.

FOREST EFFECTS OF AIR POLLUTION

Many hypotheses exist concerning possible interactions between these varied pollutants and trees and forests. The chart on page 2 highlights several of the leading hypotheses at this time and indicates possible U.S. forests of concern. Remember that the effects of air pollution are likely to vary with the tree species, soils, climate, and the variety and concentration of pollutants found in the forest in question, and that these hypotheses are not mutually exclusive. Further research is also needed on each hypotheses, research which may lead scientists to discard some of these possibilities in favor of new ones, or use them in combination with others.

While acid rain has been the focus of media attention, it may be a relatively minor contributor to forest declines in the U.S. As you read through the chart note that: 1) the wet deposition of acidic sulfur dioxide and nitrogen oxides (commonly referred to as acid rain) is only one of several possible damaging forest effects of pollution; 2) "dry" sulfur dioxide gas may enter tree leaves and then react with cell moisture to form acids, and 3) several hypotheses do not involve any acidic effects of pollution.

As indicated by the map on page 1, there is widely varying certainty in the extent to which we can attribute actual forest declines to air pollution. The following is a discussion of several U.S. forests that may be experiencing damage from air pollution, presented in order of decreasing certainty and need for further research.

CALIFORNIA MIXED FORESTS

With the exception of point-source problems, the West has generally been considered less threatened by air pollution. However, in heavily populated southern California, Forest Service scientist Dr. Paul Miller has documented ozone damage of ponderosa and Jeffrey pines, California black oak, and white fir. "Although there is only slight damage for the region as a whole, moderate to severe damage has occurred on the southern face of the San Gabriel Mountains, the western San Bernardino Mountains, and in scattered areas such as in the Sequoia National Forest and National Park, in the Sierra Nevadas," reports Miller.

EASTERN WHITE PINE

Scattered damage to eastern white pine has been reported in many parts of the tree's range, including the Appalachian and Great Smoky Mountains. The damage (changes in size and color of needles, loss of needles, and tree growth reductions) has been attributed to ozone. Dr. John M. Skelly and other researchers at Pennsylvania State University have studied white pines in the Jefferson and George Washington National Forests and throughout the Blue Ridge Mountains, including areas within Shenandoah National Park and along the Blue Ridge Parkway in Virginia and North Carolina. Eastern white pine is among the region's most sensitive species to that pollutant.

RED SPRUCE

Throughout the Appalachians, red spruce at high elevations has suffered increased mortality and growth reductions for the past 20 to 25 years (see "Attack on Our Eastern Forests" in the June 1985 issue of AMERICAN FORESTS). Circumstantial evidence suggests that the damage might be related to air pollution. Loss of foliage and fine roots are the most common visible symptoms. Affected trees also become more susceptible to damage from insects and diseases. Tree-ring analysis indicates that the growth reductions started abruptly in the mid-1960s, and have occurred over a wide range of forest sites. Red spruce at low elevations have experienced growth reductions without visible symptoms.

In the northern Appalachians, trees are losing their youngest needles first. A 1983 survey of 24 red spruce stands in the Catskill, Adirondack, Green, and White Mountains indicated that 10 percent to 30 percent of standing spruce were dead, with the greatest mortality occurring at the highest altitudes. Trees in the southern mountains lose older needles first, retaining deformed tufts of new needles on the branch tips. At the top of Mt. Mitchell in North Carolina, spruce trees average 15 to 20 percent of their normal foliage. These conditions in the southern Appalachians show the most striking similarities to the forest damage of West Germany.

Scientists have not ruled out the possibility that insects, disease, and stand age are involved in red spruce decline. But because the damage is so widespread, occurring in forests of widely differing site qualities and stand ages, it is plausible that regional rather than local stresses may be responsible. Possible regional stresses include climate changes and air pollution. Other circumstantial evidence suggests that the damage might be related to air pollution. In the northern mountains, for example, the widespread loss of young needles is characteristic of frost damage, and has led to the hypothesis that nitrogen fertilization from the atmosphere might fool trees into continuing growth too late into the fall, setting them up to be damaged during cold weather.

Observations of foliage damage and soil analysis in the forests of the southern Appalachians have suggested that trace metals in the soil, which increase in concentration with altitude, may be damaging beneficial root associations between soil fungi and bacteria. Although no study has shown that the greater metal content at high elevations alters soil organisms or other forest functions, the amount of foliar and root damage and severity of the decline do increase with elevation.

SUGAR MAPLES

Sugar maple declines have occurred in the Northeast and in nearby Canada for many years. Although there have been many, often emotional, accounts of the possible involvement of acid rain or air pollution, many scientists maintain that the most likely culprits are defoliating insects, drought, and cold/frost damage. Forest Service scientist Dave Houston first studied the declines of sugar maples as a graduate in the 1950s, and found that the combined effects of insects, fungi, drought, cold, and other stresses were responsible for the damage.

OHIO RIVER VALLEY

The Ohio River Valley, home to a heavy concentration of coal-burning power plants, produces high levels of sulfur dioxide emissions—much of which fall to earth as dry deposition. Ozone concentrations are also significant in the area. Dr. Orie L. Loucks of Butler University in Indianapolis has examined five species—white ash, tulip poplar, sugar maple, red oak, and white oak—in the immediate vicinity of major sulfur dioxide sources, and in Hoosier National Forest, farther removed from the sulfurous pollution. At each site, Loucks studied foliage, bark lichens, and ring width. Lichens were studied because their appearance is generally considered a good indicator of pollution levels in a given area. Loucks found that lichen populations nearest the pollution source were "profoundly altered" while only the more sensitive lichens were damaged in the National Forest.

Two tree species, white ash and tulip poplar, exhibited foliage damage characteristic of ozone damage. Sugar maple showed the greatest foliage damage nearest the pollution source, leading to the conclusion that foliar damage and nutrient leaching might have resulted from sulfur dioxide and ozone damage. The two oak species exhibited damage on both sites at their leaf tips, which surprised Loucks and led him to conclude that the oaks' nutrient status might have been altered in response to the general background of sulfur and ozone pollutants.

SOUTHERN PINE

U.S. Forest Service surveys for the Piedmont regions of Alabama, Georgia, North Carolina, and South Carolina have indicated unexpected growth decreases of approximately 20 percent for loblolly and shortleaf pines during the last 10 years. The increased age of the trees involved in the survey may explain part of this decreased growth. Air pollution is another possible cause, as the Piedmont region has the highest average ozone concentrations for low elevations in the eastern U.S. But, as Dr. Ellis Cowling of North Carolina State University has noted, "Air pollution is only one of six possible factors that must be considered. Other possibilities include drought, increased hardwood competition, increased density of trees in surveyed areas, increased number of ridgetop sites in survey, and fertilizer depletion that may have been on the abandoned croplands on which these trees now grow."

Forest survey data indicated that an

AFA Asks the Forestry Deans

Recently, the deans of the 70 U.S. graduate and undergraduate forestry schools toured Mt. Mitchell in North Carolina, to examine first-hand the evidence and questions surrounding its deepening mystery of dead and dying conifers. The trip was sponsored by the American Forest Institute and attracted forestry deans from every region of the country. In light of that trip, AFA asked these forestry leaders to share with the readers of AMERICAN FORESTS their opinions on air pollution and its possible effects on forest health and productivity. We recieved responses from 34 deans; some of their comments may surprise you.

Concerning current levels of U.S. forest damage attributable to acid rain or air pollution, the majority of those responding, 21 deans (roughly 60 percent of respondents), believe there is little current damage, while 10 deans (30 percent) think that moderate damage has occurred, and the remaining four deans (12 percent) said that there is no current pollution-related damage. No one thought that severe damage has already occurred for the nation as a whole.

Where, then, is forest damage that can be attributed, at least partially, to air pollution? The deans were asked to choose from a list: southern pine, eastern hardwoods, central hardwoods, western Douglas-fir, western mixed conifers, Alaskan hemlocks/Sitka spruce, Alaskan inland conifers, and "others." The unlucky winners? Eastern hardwoods with 18 votes. Appalachian spruce-fir, such as that found on Mt. Mitchell, received 14 "write-in" votes, and western mixed conifers had eight votes. However, Thomas Hansbrough, Director of the School of Forestry and Wildlife Management at Louisiana State University, claims he did not see anything different on the Mt. Mitchell tour than he observed as a forestry student in 1941 in the Clingman's Dome area of the Smokies. At that time, it was explained to him that such high-elevation forests with rocky, shallow soil are more prone to environmental extremes that trigger the successional patterns he saw.

What is causing the so-called declines now being observed in the East? Most deans implicated a combination of factors including acid rain, ozone, other forms of air pollution, insects, fungus, disease, management history, and drought or other climatic factors. Dr. Gregory N. Brown, Dean of Forestry at the University of Maine at Orono, noted, "Much evidence suggests that air pollution intensifies damage in forests already weakened by climatic, insect and disease factors. As Dr. Bart Thielges, head of the Forestry Department at the University of Kentucky, explained, "We are now experiencing declines that are due to a complex of stresses—drought, pests, management practices—that may be unexpected decrease in rates of tree growth of longleaf and slash pines has also occurred in the coastal plain regions of other southern states.

Although "acid rain" has been at the center of the ongoing Congressional debate on air pollution control, current research indicates that other pollutants, in addition to acid rain, may have the potential to damage forest resources. In fact, forests have now become a pivotal concern in the debate even though a definitive cause-effect relationship has not yet been established. And while there is no doubt that increased and integrated research efforts are needed to better understand air pollution's roles in forest decline and death, any attempts to study or control air pollution and its possible effects on forests should not be narrowly focused on acid rain alone, but should include the broader spectrum of pollutants. **AF**

The authors wish to thank Charles Philpot and Dave Radloff of the U.S. Forest Service for their help in the preparation of this article. The views expressed here are the authors' and not necessarily of the Congressional Research Service or AFA.

THE FOREST ECOSYSTEM

Continued from page 4

take. The level of plant growth is only as great as that allowed by the nutrient that is most limited. Nitrogen is usually the critical limiting nutrient for growth in a forest ecosystem, so it is often added as a fertilizer. But if the forest is either "over-fertilized" or deficient in any essential nutrient, plant life will suffer.

As dead leaves, twigs, and animals litter the forest floor, soil, bacteria, and fungi complete the life cycle by consuming the litter, thereby replenishing the soil with the vital minerals and nutrients used by the trees and other plants. This process is called decomposition. Forest vegetation is often naturally acidic. As litter from these species decomposes, a strong acidity can develop in the soil. Acids can combine with soil moisture to leach minerals out of the soil.

In many forests, however, the vital soil functions and nutrient availability are usually maintained, sometimes through a symbiotic relationship between tree roots and a group of fungi called mycorrhiza. Plant growth is superior in areas where this relationship exists, because it significantly increases uptake of nutrients through the roots. This relationship, and compounds containing calcium and magnesium, usually arm most soils with the capacity to buffer, or neutralize, acidic components of the system.

Because the balance of forces that create and sustain the forest is amazingly intricate, exact quantification of an ecosystem is practically impossible. For example, the level of soil nutrients sufficient for optimum growth of most plants is not known. General concepts about trees and their ecosystems can be viewed only as a framework; forests reflect the sensitivity of individual trees to specific environments. And due to the dynamics of such strong interlocking forces that exist among trees and within forests, it is not always possible to predict how changes may affect the forest ecosystem.—ADELA BACKIEL

WHAT ABOUT FOREST DECLINE?

triggered and/or intensified by atmospheric emissions problems that may affect soils and water resources as well as the air."

We also asked the deans how they would rate the potential threat to our nation's forest resources from air pollution in general and from acid rain. The deans make a clear distinction between these two terms. While 26 deans indicated that air pollution posed a moderate threat to forests, only 17 deans indicated acid rain, by itself, as being a moderate threat.

While most deans called for an expansion of the current research on forest effects of air pollution, several deans also questioned the role of scientists in the political debate over air pollution. "I am especially concerned with the need for forest scientists to maintain objectivity, avoid biased statements, and to proceed with care and caution," said Dr. Donald L. Mader, Chairman of Forestry and Wildlife Management at the University of Massachusetts at Amherst. "Otherwise we may put ourselves out on a limb with premature judgments and lose the public's confidence if dire predictions turn out to be exaggerated or untrue." Dr. Kent T. Adair, Dean of Forestry at Stephen F. Austin State University in Texas, had another warning: "Forest research must be careful not to seek biological truth in response to a social question. Forest decline is as much a social as a biological concern, and people will demand action while viewing the tedious process of research as obstructionism. This helps neither forest research nor forest health."

Almost half of the deans responding felt that regulatory action to reduce air pollution emissions is warranted at this time to protect forest resources. As George Dutrow, acting Dean of the Duke School of Forestry and Environmental Studies in North Carolina, put it, "It would be naive to assume that current levels of pollution will not produce a cumulative effect on terrestrial ecosystems; it would also be naive to wait until symptoms were so severe as to be unequivocal. We should look for probable patterns (based on field data collection, short-term experiments, etc.), make rational decisions, but not wait irrationally for certainty to come along—autopsies give the best criteria for diagnosing diseases. On the other hand, I don't feel the current level of damage has been well-established, and I am not sure it can be until it becomes unacceptably large."

Or, as Dean Adair expressed it, "The regulation of pollution emissions should not be based on forest resources alone, but on the broader dimensions of environmental quality. There is merit in clean air regardless of its specific relationship to forest health."

—FRANCES A. HUNT

TREES, FORESTS, FORESTRY–AND AFA

The American Forestry Association's principal purpose is education. As *the* national citizens organization for trees, forests, and forestry, AFA faces a vast and diverse classroom. We are making progress, but there is so much to do.

Our message is simple enough. It is that trees and forests can and must be replenished. As a nation, we use them to satisfy many of our needs, needs that will continue as long as we exist. Wise use of these resources will assure that they will continue to meet our needs.

We made some progress recently in getting our message to the people. Like television, AFA has different channels. AMERICAN FORESTS has a new, modern design. We added a newsletter, the **AFA Resource Hotline** to keep the forestry community better informed on conservation issues. Our offices in Washington have become the center for meetings and work sessions on resources conservation. The AFA staff, including the regional representatives, have been more active than ever in working with groups outside of Washington. It is the message itself, however, that is most important. What do we say?

We say that tree planting is important. And Congress listens. Success has many fathers, while failure is an orphan. But the insiders in Washington know that AFA played a central role in getting a strong "Conservation Reserve" section in the 1985 Farm Bill. The result is that up to 5 million acres of highly erodible lands will be planted with trees in the next few years. This will be *the largest tree-planting program we have ever had in this country*. It will help to hold soil in place, rather than letting it go "helter-skelter downriver," as Aldo Leopold once said.

We say that air pollution is a major threat to forests. Articles in AMERICAN FORESTS hammered on this issue and explained its complexity. We appointed a committee of the Board of Directors to monitor findings on this issue so that we can provide responsible leadership.

We say that private forest owners need help in forest conservation. AFA's annual meeting in Traverse City, Michigan, 1985 let forest landowners tell us and each other what they need for management of their forests. We have translated these needs into action positions and have helped form the National Council on Private Forests.

We tell the Forest Service and Congress that a better balance is needed in funding programs for the National Forests. Our analyses of the federal budget are now the basis conservation groups are using to identify the most important funding problems. It is clear from these analyses that recreation and wildlife programs on the National Forests are not being adequately funded.

We say that individuals are important in forest conservation. In 1985, AFA gave its major awards to six people, including a husband-and-wife team, who had been active in various phases of forest conservation, including research, industrial forestry, government, nonprofit conservation organizations, and philanthropy. I am proud of the AFA awards and of their recognition of outstanding service to conservation by individuals.

We try hard, but there is so much to do. But as Dr. Larry Tombaugh said at our Traverse City meeting, the conservation challenge we face is **"to instill a sense of obligation concerning the land and forests in the hearts and the minds of all Americans....We cannot afford to fail."**

Perry Hagenstein
President,
American Forestry Association

Interested in AFA? Use this handy form or just send us a copy.

Yes! I support AFA's work for trees, forests and forestry—and I'd like to join! I understand that I will receive monthly issues of AMERICAN FORESTS, AFA's informative and entertaining magazine.

Name ____________________ Daytime phone __________

Address ____________________ Evening phone __________

City ______________ State ____________ Zip ________

Contributions are tax deductible. Check your desired membership category:
☐ $24 Annual ☐ $40 Two-Year ☐ $50 Contributing ☐ $100 Sustaining ☐ $350 Life

☐ Check enclosed ☐ Mastercard or Visa

Visa Card # ____________ Exp. date ______ Mastercard # ____________ Exp. date ______

Signature: ____________________________

The American Forestry Association, 1319 18th Street, NW, Dept. AR, Washington, DC 20036.

Issue Brief

Order Code IB86031

ACID RAIN, AIR POLLUTION, AND FOREST DECLINE (WITH APPENDIX)

Updated May 28, 1987

by

Adela Backiel

Environment and Natural Resources Policy Division

Congressional Research Service

CONTENTS

SUMMARY

ISSUE DEFINITION

BACKGROUND AND ANALYSIS

Air Pollutants as a Source of Forest Stress

Hypotheses to Explain the Role of Air Pollutants in Forest Decline

Federal Research Activities

Policy and Legislative Issues

Legislative Activity

LEGISLATION

CONGRESSIONAL HEARINGS, REPORTS, AND DOCUMENTS

FOR ADDITIONAL READING

ACID RAIN, AIR POLLUTION, AND FOREST DECLINE (WITH APPENDIX)

SUMMARY

Forests in several areas of the United States are showing evidence of a decline in productivity, many from unknown causes. Acid rain and other air pollutants are seen as possible causes, or contributing factors, in these declines, although no causal link has been firmly established. The primary pollutants under investigation are sulphur dioxide, nitrogen oxides, and reactive hydrocarbons. Secondary pollutants such as acidic deposition and ozone are also under scrutiny. The effect of acid rain and air pollution on forests, both confirmed and disputed, has become a major issue in the current legislative debate over pollutant emission controls.

Few forest declines in the United States can be conclusively attributed to air pollution. The most common hypothesis for forest declines is one of general stress where natural stresses such as insects or diseases work in concert with one or more anthropogenic factors such as air pollution to cause a decline in productivity. Many other hypotheses exist including both direct effects of air pollutants on tree foliage and indirect effects from pollution induced changes in the soil.

Federal research on the effects of acid deposition and air pollution on forests has increased significantly over the past few years. The current forest-related research program, headed by the USDA Forest Service and the Environmental Protection Agency (EPA), is anticipating more definitive information on the role of acid in observed forest effects in the short term. The key forestry issues relating to the debate on pollutant emission controls are whether the immediate problem is so exigent as to warrant immediate controls, and if controls are warranted, which pollutants the program should address. Opponents to control bills state that additional regulation should be postponed until these and other questions can be conclusively answered. Advocates of additional pollution controls contend that delay could cause irreversible and irrevocable damage.

ISSUE DEFINITION

Forests in several areas of the United States are showing evidence of decline. Although U.S. forests have periodically suffered ill health from known causes, there is no scientific consensus explaining the cause and effect relationship for many of the current declines. Acid rain and air pollution generally are suspected agents in some of the declines, but a wide range of interconnected causes may be involved.

This issue brief discusses the nature and extent of forest decline, some explanations for this decline, and the Federal response to address this situation. The central issue is whether acid rain and/or air pollution contributes to the cause of forest decline, and how this factors into the current congressional debate over pollutant emission controls.

BACKGROUND AND ANALYSIS

Forest decline involves a complex set of biological and nonbiological stress factors, as opposed to a plant disease in which death of one species can be attributed to one cause. Symptoms of decline can be obvious or invisible to the naked eye, rapid or progressive, chronic or acute. Resulting damage can include reduced growth, crown and twig dieback, yellowing of leaves and needles, decreased leaf size, thinning and death of leaves and needles, and deterioration of roots.

Most of the attention and research on the possible air pollution effects on forests have been focused on the eastern and southern parts of the United States. Despite documented ozone damage in southern California for Ponderosa and Jeffrey pines, California black oak, and white fir, and despite specific point source pollution problems (e.g. forested areas surrounding smelters), the West has generally been considered less threatened by regional air pollution.

In scattered areas of the Appalachian and Blue Ridge Mountains, damage to eastern white pine has been confirmed. At high elevations, red spruce has also suffered significantly increased mortality and growth reductions for the past 20 to 25 years, but without conclusive links to air pollutants. Loss of foliage and fine roots are the most common visible symptoms, sometimes leading to more susceptibility to damage from insects and disease. Red spruce at low elevations have also experienced growth reductions but without other obvious symptoms.

Forest surveys for the Piedmont regions of Alabama, Georgia, North Carolina, and South Carolina have indicated unexpected growth reductions of approximately 20% for loblolly and shortleaf pines during the last 10 years. An unexpected decrease in rates of tree growth of longleaf and slash pines has also occurred in the coastal plain regions of other southern states.

In the Ohio River valley, white ash, tulip poplar, sugar maple, red oak, white oak and various bark lichens show various symptoms and degrees of damage from the pollution. The health of lichens is often used as an indicator of pollution in a given area.

Forest decline is best understood within the context of the entire forest ecosystem. Generally, the ecosystem has the capability to adjust to change and maintain an equilibrium; if any one of the ecosystem components is substantially altered, as from a natural or man-made stress factor, the entire ecosystem can be affected.

Most forest stresses are familiar, natural substances or situations, encountered and accommodated on a daily basis, which can be cast into three categories: biological, physical, and chemical factors. Biological factors primarily include insects, fungi, and viruses. Physical factors can involve climatic extremes of heat and cold, moisture supply, and high winds; geographic location; age of the forest; wildfires; and human activities such as prescribed burning, logging, or construction damage such as soil compaction. Chemical factors include the natural and anthropogenic (human- origin) gases such as sulfur dioxide, nitrogen, and ozone; potentially toxic metals such as aluminum and lead; acidic substances such as sulfuric and nitric acids; and growth-altering organic chemicals, such as ethylene.

Because of the resiliency of the forest ecosystem, most trees and forests recover from the effects of stress. However, at a critical tima, one factor could — like the straw that broke the camel's back -- push a tree, or an ecosystem, from a weak but stable situation, into a vulnerable and declining condition. Also, each individual tree species and/or forest can respond to these stresses in a different manner. At the same time, various stresses or declines can produce the sama symptoms.

Air Pollutants as a Source of Forest Stress

One of the most recent types of stress that trees and forests have had to accommodate is air pollution. Pollutants are generally identified as primary or secondary, depending on how they are formed. Primary pollutants are directly emitted into the atmosphere, predominantly in gaseous forms and include sulphur dioxide (SO2), nitrogen oxides (NOx), and reactive hydrocarbons (RHC), which are carbon compounds and mixtures such as ethylene and gasoline. The burning of fossil fuels — coal, natural gas, and oil -- produces a large portion of these pollutants; industrial, utility, and power plants emit large quantities of tha SO2 and NOx. Mobile sources, such as transportation vehicles, are responsible for large amounts of NOx and RHCs. Petroleum refining and storage produces reactive hydrocarbons, although the majority are produced from numerous smaller sources such as the use of paint solvents and dry cleaners. Metal ore smelters can release SO2, in addition to toxic elements such as lead, cadmium, nickel, and fluoride. Lead can also come from burning leaded gasoline.

Secondary pollutants are formed during chemical reactions in the atmosphere involving the primary pollutants. One of the most commonly known is acidic deposition, which is produced when SO2 and sulphur oxides (SOX) or NOX combines with oxygen in the air to form acidic gases or particulates (dry deposition) or, in combination with moisture, it can occur as acid snow, hail, dew, fog, or rain (wet deposition, or "acid rain").

Another type of secondary air pollutant -- photochemical oxidants -- is produced when energy provided by sunlight triggers reactions involving NOX and atmospheric oxygen. Ozone (O3), the most common oxidant, is a gas that is extremely toxic to both plants and humans. Like primary pollutants, secondary pollutants can travel long distances. Secondary pollutants can best be controlled by limiting their precursors, or by restricting other chemical compounds that may control the precursor rate of transformation. For example, production of ozone is highly dependent on the ratio of hydrocarbons to NOx in the atmosphere -- thus control of ozone could theoretically be accomplished by limiting either hydrocarbons or NOx to meet the correct ratio, though NOx can be controlled more easily than hydrocarbons.

Hypotheses to Explain the Role of Air Pollutants in Forest Decline

Many studies have shown that local (point source) air pollution can harm vegetation including forest growth. However, the effects of regional air pollution on forest growth are not as well documented. Regional air pollutants may have direct effects on trees through the leaves and stems, and indirect effects, primarily through the soil.

Many forest scientists also believe that air pollution could make a tree or forest more susceptible to natural stresses, such as insects, diseases, drought, or winter frost damage. Consequently, the most common theory advanced to explain the cause of current forest declines, called the general stress hypothesis, is that varying combinations of climate extremes, pests and pathogens, or other natural stresses, in concert with one or more anthropogenic factors, may be responsible. Very few of the American forest declines can be conclusively attributed, in whole or in part, to air pollution.

Many hypotheses exist in addition to this general stress hypothesis. These include both direct effects of air pollutants on tree foliage and indirect effects from pollution induced changes in the soil. Appendix 1 summarizes the leading hypotheses derived from a survey of scientific literature. Possible U.S. forests of concern are also indicated, although the effects are likely to vary with the tree species, soils, climate, and the variety and concentration of pollutants found at any individual site.

The following general points can be derived from reviewing Appendix 1 regarding the link between air pollutants and forest decline: 1) the wet deposition of acidic solutions of sulfur and nitrogen oxides (commonly referred to as acid rain) is only one of several possible forest damaging effects of pollution; 2) "dry" sulfur dioxide may enter tree leaves and then react with cell moisture to form acids; 3) several hypotheses do not involve any acidic effects from pollution; and 4) the hypotheses are not mutually exclusive.

Federal Research Activities

The USDA Forest Service has been researching certain forest declines and possible effects of air pollution on forests for many years. In 1980, an independent organization was enacted called the National Acid Precipitation Assessment Program (NAPAP) to coordinate research activities and periodically report to Congress on the acid rain issue. The NAPAP research program reports expenditures of over $80 million annually.

The Terrestrial Effects Task Group of NAPAP is a multiagency effort to explore the effects of acid deposition on crops and forests. The majority of work focuses on forest effects. The NAPAP research budget for forestry research has increased significantly over the past few years from about $1 million in FY84 to over $16 million in FY87. Most of the forest related research conducted through NAPAP is supported by the Forest Service and the Environmental Protection Agency (EPA) in an organization called the Federal Management Group. This research is conducted through four, five-year Cooperatives focused on specific forest types. The National Council of the Paper Industry for Air and Stream Improvement (NCASI), the research arm of the forest products industry, and scientists from many universities, also contribute to the research Cooperatives. In support of the Cooperatives, a Deposition Monitoring Program is managed by EPA as part of the Federal Management Group.

The current Cooperatives address four forest types: the southern pine forests, the spruce-fir forests, western coniferous forests, and the eastern hardwood forests. The Cooperatives focus on determining the effects of acid deposition or air pollution on trees and forests and whether they contribute to declines in forest productivity.

Policy and Legislative Issues

Throughout the legislative debate on acid rain, issues have focused on what control programs, if any, are appropriate to abate acid rain. The continuing question is the most basic: is the problem so exigent as to warrant immediate controls? Some argue that delaying action would allow better information on the problem and solutions which might result in a more effective and less costly program. Others contend that delay risks irreversible and unacceptable damage.

An understanding of the effects of acid rain and air pollutants on various resources is central to the debate over additional regulations to control air pollutants. With regard to forestry, there are still many unknowns as to the extent of damage from air pollutants, and the cause of productivity declines and their impacts on the forest products industry.

The Administration takes the position that additional regulation is premature and more research into the effects of air pollution is necessary. A joint statement on transboundary air pollution issues was issued in January 1986 from the Special Envoys appointed by President Reagan and Canadian Prime Minister Mulroney. Their recommendation on forest effects was that "research should be accelerated to investigate the potential link between forest and tree decline and acid rain as a causal or contributing factor." The increased current research program partially is the result of the this recommendation. As stated in the Joint Report to the Bilateral Advisory and Consultative Group on the Status of Canadian/U.S. Research in Acidic Deposition in Feb. 25, 1987, the current research program expects some answers in the short-term as to the role of acid deposition in observed forest effects. The program is also expected, over the longer term, to establish the effects on forests, if any, of acid rain, air pollution, and natural stresses, alone or in various combinations.

Proponents of emission controls maintain that the risk to the environment associated with the consequences of not doing anything to control precursors of acid rain or suspected pollutants outweighs the uncertainty of specific cause-effect relationships; the best available scientific information and circumstantial evidence suggests to them that a control strategy must be initiated before delay causes irreversible damage.

Although the lack of undisputed evidence does not enable the scientific community to speak with one voice, empirical research, circumstantial evidence, and some of the best available scientific information suggest that air pollutants could be working alone or in conjunction with natural stresses to damege forest health, vigor and productivity.

Additional issues for those proposing or debating controls include, whether, if controls are warranted, the program should focus of SO_2 first, or include NOX and other pollutants as well. While the potential benefits from SO2 reductions are projected to be substantial, such reductions alone may not adequately protect ecosystems, such as forests, However, a more comprehensive bill may be more difficult and time consuming to pass.

Legislative Activity

In May, 1986 the House Agriculture Committee, Subcommittee on Forests, Family Farms and Energy, held hearings on H.R. 2631; mark-up followed in early June. An amendment in the nature of a substitute was accepted by the subcommittee which combined provisions of H.R. 2631 with H.R. 2963 (which was reported by the Interior Committee in 1985). The bill H.R. 2631, as amended, was approved unanimously by the Subcommittee on June 12, 1986; it was approved unanimously by the full Agriculture Committee on July 23, 1986. The bill passed the full House by a vote of 416 to 4 on Aug. 13, 1986. There was no subsequent action in the Senate before adjournment of the 99th Congress. It is likely that similar bills will be considered in both the House and the Senate in 1987.

Appendix to IB86031
page 1 of 1
02/13/86

POLLUTANT	HYPOTHESIS	EXPECTED SYMPTOMS	POSSIBLE FORESTS AFFECTED
DEPOSITION OF WET AND DRY ACIDIC SULFUR AND NITROGEN OXIDES (SO_x and NO_x)	Acid deposition may reduce normal nutrient level available to trees: 1) speeding the normal leaching of nutrients directly from leaves or needles. If affected trees cannot sufficiently replace these nutrients, deficiencies can alter normal life and growth processes.	• Yellowing and browning of foliage	• Forests that are frequently cloud or mist-covered and exposed to atmospheric pollution
	2)Acidifying forest soils. As soils become more acidic, nutrients (such as calcium and magnesium) can be removed.	• Soil acidification • Yellowing and browning of foliage	• Forests on nutrient-poor soils
FERTILIZATION BY NITROGEN OXIDES (NO_x)	Nitrogen overfertilization: 1) Too much nitrogen "fools" trees into continuing to grow late in the fall. Winter cold can damage and kill foliage that is not prepared.	• Red-brown discoloration of preceding year's foliage	• High-elevation forests; e.g., red spruce in northeastern Appalachians
	2) Nitrogen-fertilized plants respond by increasing growth above ground, but this is not offset by increased root growth. Total root system may actually be decreased, making tree more susceptible to drought, other stresses.	• Decreased root mass and mycorrhiza	
GASEOUS POLLUTANTS Ozone and Other Photochemical Oxidants	A sudden onset or sharp rise in ozone can damage—or kill leaf cells, leading to decreased photosynthesis, loss of water, and increased leaching or removal of nutrients from foliage.	• Death of cells in leaves and needles • Purple/black on broadleaves • Premature aging of foliage • Reduced growth	+ White fir, California black oak, Ponderosa, & Jeffrey pines in southern California + White pine, eastern U.S. • Loblolly, and shortleaf pine in Piedmont forests of AL, GA, NC, SC
Sulfur Dioxide (SO_2)	Chronic ozone exposure in combination with acidic rain or fog increases nutrient loss from foliage, which leads to reduced photosynthesis and root growth.	• Yellowing or browning of foliage	• High-elevation forests in Northeast
	SO_2 can enter plant through stomata and react with water to form acids. Acute or chronic exposure can damage or kill cells in leaves, reducing photosynthesis.	• Yellowing or browning of foliage • Often no visible injury • Premature needle loss	• Point-source problems (e.g. smelters in Sudbury, Ontario)
TRACE METALS Aluminum Mobility	As soil acidity rises, aluminum increases to toxic levels and can displace beneficial nutrients, inhibit their uptake, and damage fine root hairs, leading to nutrient and moisture stress.	• Loss of leaves or needles • Soil acidification • Death of fine roots	• No evidence in U.S. (highly suspected in W. German forests)
Heavy Metal Deposition	Metals exist in cells in trees amounts. Excess amounts could interfere with photosynthesis, root growth, and reproduction.	• Slow rate of decomposition	• High-elevation spruce-fir ecosystems in southeastern U.S. • Localized pollution problem areas particularly close to smelters
GROWTH-ALTERING SUBSTANCES	Synthetic organic substances may stimulate abnormal growth and development, particularly in foliage.	• Browning and death of leaves and needles • Loss of green foliage	+ Loblolly pine in North Carolina

+ Denotes general scientific acceptance of linkage to noted causal agent.

DEPOSI
JAN 25 198
SHIPPE

Y 4.AG 8/1:100-40 C.1
Forest Ecosystems and
Stanford University Libraries
3 6105 045 082 539

DATE DUE

STANFORD UNIVERSITY LIBRARIES
STANFORD, CALIFORNIA 94305-6004

GAYLORD